The Engineer.

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THE ENGINEER.

A Seven-Day Journal

Industrial Research.

THE report for the year 1934–35 of the Department of Scientific and Industrial Research, issued by H.M. Stationery Office on December 28th, shows that there are now twenty-one industrial research associations in existence. Most of them appear to be carrying on their work with increased activity. The highest grant paid by the Department to any of the associations during the year was £15,500 which went to the British Cotton Industry Research Association, a body which has been in existence for sixteen years and which during that time has received in grants a total sum of £171,290. The British Electrical and Allied Industries Research Association received £8000 bringing the total value of the grants received during the fourteen years of its existence up to £122,378. Metallurgical research is in the hands of three associations, the Non-Ferrous Metals Research Association, the Cast Iron Research Association and the Iron and Steel Research Council. These bodies last year received grants of £7500, £5000 and £10,000 respectively. They have been in existence fifteen, fourteen and six years and during their lives have received grants totalling £86,324, £50,207 and £38,166. Three of the associations, those dealing with the Scottish shale oil industry, the coal industry and the printing industry, do not receive grants from the Department. Efforts made by the Department to induce certain industries to support their research associations with increased liberality have, it seems, met with a gratifying response. Out of thirteen associations which in the Department's opinion were not satisfactorily situated from the financial standpoint, twelve now enjoy an income of at least £10,000 a year while the thirteenth will, it is believed, reach that level during the coming twelve months.

Railway Finance Corporation.

THE new financial undertaking which will raise the Treasury guaranteed loan of £26,500,000 for improvements on the four main line railways was registered on December 24th as a public company under the above title, the registered offices being 5, London Wall-buildings, E.C.2. The corporation has a nominal capital of £100 in £1 shares, but the directors have powers to borrow up to £26,500,000. The objects of the corporation are to finance the four big railways or any other transport undertaking in any manner approved by the Treasury. The first directors are Messrs. Walter K. Whigman, Charles J. Hambro, Sir Josiah Stamp, Messrs. Edward Holland-Martin, and Kenneth O. Peppiatt. They are not bound to hold shares nor are they entitled to any remuneration for their services. The particular object of the corporation is to carry out with or without modification an agreement between the Treasury and the four main line companies made on November 30th last, to borrow and lend money, and to make such contracts, &c., as may be necessary to carry out the agreement. The total cost of the works to be carried out under the main line railways' scheme is estimated at £29,500,000, to be spent over a period of five years. The three million required to complete this figure is to be found by the railway companies.

The Mohammad Aly Barrages.

THE Egyptian Government has invited tenders for the construction of two new barrages to replace the existing Delta Barrages, about 20 kiloms. north of Cairo, where the river Nile bifurcates and becomes the Rosetta and Damietta branches of the river, which, when completed, will be one of the most important works ever undertaken for the control of the river Nile. Their function will be to raise the level of the river upstream and to distribute the water of the Nile into three main canals, namely, the Behera Canal, which supplies water for irrigation purposes to the western portion of the Delta, as far as Alexandria; the Menoufia Canal, to the central portion; and the Tewfiki Canal, to the eastern portion in the direction of Port Said. The new Rosetta barrage will have forty-six openings, and the new Damietta barrage thirty-four, each 8 m. in width, closed by heavy mild steel sluice gates operated by overhead power-driven machines. There will be a navigation lock in each barrage with a swing bridge to take vehicular traffic, the latter being provided for on the barrages by a wide roadway capable of accommodating two lines of traffic. The construction generally will be in concrete faced with granite procured from Aswan. In addition to the two barrages, the contract will include the construction of a new canal head regulator for the Behera Canal, consisting of six openings, each of 8 m., and a navigation lock in connection therewith, the remodelling of the Tewfiki canal head regulator, another small regulator, and sundry minor works and bridges. The existing barrages, with their towers, archways, and quaint timber drawbridges, will remain and be used for light motor and vehicular traffic. The consulting engineers for all the above-mentioned works are Messrs. Coode, Wilson, Mitchell and Vaughan-Lee, of Westminster.

Factory and Workshop Accidents.

ON January 1st an extension to the Notice of Accidents Act, 1906, came into force under the Dangerous Occurrences Notification Order, 1935, which requires that notice be given of the following classes of accidents in a factory or workshop to a Factory Inspector, irrespective of whether or not personal injury or disablement is caused. The accidents to be reported include all cases of bursting of a revolving vessel, wheel, grindstone, or grinding wheel moved by mechanical power; collapse or failure of a crane, derrick, winch, hoist, or other appliance used in raising or lowering persons or goods, or any part thereof (except the breakage of chain or rope slings), or the overturning of a crane; explosion or fire causing damage to the structure of any room or place in which persons are employed, or to any machine or plant contained therein, and resulting in the complete suspension of ordinary work in such room or place or stoppage of machinery or plant for not less than five hours, where such explosion or fire is due to (i) the ignition of dust, gas, or vapour, or (ii) the ignition of celluloid or substances composed wholly or in part of celluloid; electrical short circuit or failure of electrical machinery, plant, or apparatus, attended by explosion or fire or causing structural damage thereto, and involving its stoppage or disuse for not less than five hours; explosion or fire affecting any room in which persons are employed and causing complete suspension of ordinary work therein for not less than twenty-four hours; explosion of a receiver or container used for the storage at a pressure greater than atmospheric pressure of any gas or gases (including air) or any liquid or solid resulting from the compression of gas.

The Safety of British Ships.

IN order to prevent wrong inferences being drawn from the publicity given to the distressing losses of British ships during the last year, a statement was issued on Saturday last, December 28th, by the Chamber of Shipping. It points out that weather conditions during the last year or two have caused more losses than in the preceding period, though these losses are less than in earlier years. The statistics show that losses of British vessels to-day amount to only about 40 per cent. of the pre-war figures, while the losses of foreign vessels are about 50 per cent. Since 1920 the three-year averages of seagoing vessels of 1600 tons gross and upwards lost to the United Kingdom have been:—1920–22, 0·64 per cent.; 1923–25, 0·52 per cent.; 1926–28, 0·52 per cent.; 1929–31, 0·46 per cent.; 1932–34, 0·41 per cent. Great Britain is owner of 33½ per cent. of the world's tonnage, but has suffered only 25 per cent. of the world's losses. The loss of life among officers and seamen serving in British trading vessels during 1910–14 averaged 0·24 per cent., or if the quite exceptional disasters to the "Titanic" and the "Empress of Ireland" be ignored, the figures averaged 0·17 per cent. The loss of life during 1922–26 averaged 0·102 per cent., during 1927–31 0·045 per cent., and during 1932–34 0·042 per cent. These figures indicate that the safety of life at sea is from four to six times as great as before the war. The statement goes on to point out that while the safety of life at sea with all nations is dependent more on science than on regulations, in particular on the developments and improvements of the marine engine and other machinery, of wireless and of the aids to navigation, in Great Britain the relative freedom from loss at sea is due to the quality of British masters, seamen, ships, and management, and the strictness with which regulations are carried out. We have more ships under ten years old and fewer ships over twenty years old than any other country, and we own nearly 50 per cent. of the tonnage over 10,000. The British mercantile marine has been the pioneer of safety regulations which have been supported by foreign shipowners. As a result, the law has been brought to a very high standard, and is effectively administered throughout the world.

The Employment Figures.

ACCORDING to a statement issued by the Ministry of Labour on Monday evening, December 30th, it is estimated that at December 16th, 1935, there were approximately 10,599,000 insured persons, aged sixteen to sixty-four, in employment in Great Britain. This was 62,000 more than at November 25th, 1935, and 340,000 more than at December 17th, 1934. There was a further improvement, between November 25th and December 16th, in coalmining, iron and steel manufacture, and the engineering and cotton industries. Employment also increased in the distributive trades, motor vehicle, cycle, and aircraft manufacture. On the other hand, employment continued to decline in building and in pottery manufacture. At December 16th, 1935, the numbers of unemployed persons on the registers of Employment Exchanges in Great Britain were 1,585,990 wholly unemployed, 205,574 temporarily stopped, and 77,001 normally in casual employment, making a total of 1,868,565. This was 49,997 less than the number on the registers at November 25th, 1935, and 217,250 less than at December 17th, 1934. The total on December 16th, 1935, comprised 1,501,576 men, 53,959 boys, 267,109 women, and 45,921 girls.

The Great Western Railway Programme.

ON Saturday, December 28th, the Great Western Railway announced its programme of renewals and additions to rolling stock and permanent way to be carried out in 1936. It does not include the works to be carried out under the Government Guaranteed Loan Scheme, but is, nevertheless, one of the largest undertaken for some years. The locomotive programme includes the construction at the Swindon works of twenty-five of the "Castle" class engines, similar to that used on the "Cheltenham Flyer"; ten of the "Hall" class; and one hundred 4–6–0 locomotives of a similar type for general purpose duties. In addition, the programme includes ten tank locomotives for auto-train work and eighty standard tank locomotives. The new passenger stock will consist of 302 vehicles, including 172 of the "Cornish Riviera" type for long-distance work, ten coaches of the centre-vestibule type designed for pleasure parties, and two composite coaches having third class at one end and a cafeteria at the other. The railway already operates the highest proportion of completely fitted vacuum brake freight stock in the country, and the 1936 programme provides for a further 1250 vehicles of this type, consisting of 500 "container" wagons and 750 12-ton covered wagons. In addition, fifty 20-ton goods brake vans, 2100 open 12-ton wagons, and 100 20-ton rail and timber wagons of the "non-braked" type are provided for. The reconstruction, wholly or in part, of some fifty bridges and the renewal of 406 miles of line are proposed.

Aeronautics in 1935.

No. I.

THE year 1935 will, it is certain, pass into history as a momentous one in the aeronautical world. The influences at work have however been political rather than technical although there can be no doubt that the political events will have—and indeed are already having—important repercussions on the technical side.

The dominant factors on the political side were the open abandonment by Germany of those clauses of the Versailles Treaty which prohibited her from possessing a military air force and the abandonment by Great Britain of her policy of keeping her air force at a low level. Other countries having failed to follow our example of aerial disarmament, the Government, after ten years of vain endeavour, announced in May that its new policy would be based upon the provision as quickly as possible of an air force as strong as that of any country within striking distance of our shores. This policy, reduced to figures, means that by March 31st, 1937, seventy-one new squadrons will have been formed for home defence purposes, and that 2500 pilots and 20,000 other ranks will have been added to the strength of the Royal Air Force. By the date named there will be available for the defence of the country 1500 first-line machines while in addition increases will be made in the strength of the Fleet Air Arm, Army Co-operation Units and units stationed overseas, which will bring the total number of first-line aircraft up to about 1940.

On the manufacturing side the Government's programme had an almost immediate effect. It is not to be supposed that the provision of the considerable number of machines and engines required under it will in any way overtax the capacity of the British industry. The requirements will be met by the time specified and they will be fulfilled without sacrificing the very valuable foreign connections which many of our manufacturers have built up. The industrial reaction was chiefly noticeable in such respects as a shortening of the time between the production of a new type and the placing of orders for it in quantity, the adoption of existing or adaptable types in preference to concentration on radically new patterns and the placing of orders with several firms for machines originally designed and produced by other manufacturers. Specific instances of these developments will be found mentioned in our later notes on the work done during the year by representative British firms engaged in the aeronautical industry.

On the side of design and technical progress the political events of the year are bound to have a potent effect. Since the end of the war technical developments, great as they have been, have proceeded without much stimulus from international competition in a military sense. The Government's disarmament policy did not encourage either numerical or technical competition. Our manufacturers and our research departments were not pressed unduly in their efforts to develop aeronautical practice and science. In some respects the conditions were, perhaps, made too easy by the absence of serious foreign rivalry. A tendency developed to concentrate on the improvement of well-tried types of machines rather than to launch out into new designs. Perforce that tendency is to-day continuing to exert its influence on the steps being taken to satisfy the Government's programme of expansion. It would, however, be folly to ignore the fact that the re-entry of Germany into the circle of the world's Air Powers has completely changed the situation. Germany, a first-class scientific nation, is rapidly building up her air force with machines of types which have not been evolved from earlier designs, which embody, in fact, a fresh outlook on military aeronautics. In this country it is obvious that some of the designs on which we have placed reliance for a number of years have reached the limit of their possible development. If we are to maintain our position not only with respect to numbers but as regards technical quality and performance it is essential that the changed conditions of the international situation which last year produced should be fully borne in mind. To put it briefly and to deal with one aspect only; we must no longer think in terms of 250 miles-an-hour speeds but concentrate on at least 350.

That our resources are fully capable of carrying us on to the new level which the aerial rearmament of Germany has necessarily imposed upon us, there need be no doubt. Once the Government's immediate needs under the new programme are satisfied we may expect to see important technical developments in the design and performance of British aircraft. Towards that end our research departments are already well equipped, a notable addition in this respect being the opening during the year of the full-scale 24-foot wind tunnel at Farnborough. Of the industry's ability to take full advantage of the scientific progress which will result we have every assurance from its work in the past.

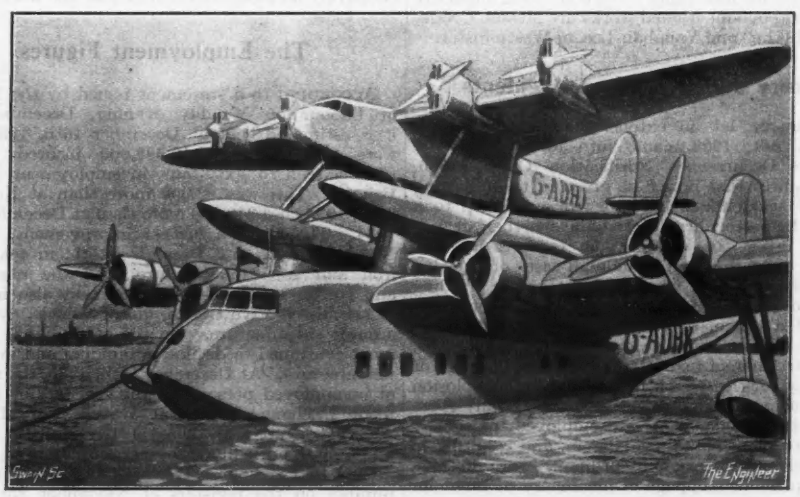
IMPERIAL AIRWAYS.

The two agreements between Imperial Airways, Ltd., and the Government—one covering the European and the England–India services and the other the England–South Africa service—expire in 1939 and 1937 respectively. For some time past the renewal of these agreements has been under discussion. The principal features of a new long-term agreement have now been settled. The company is to continue as the Government's chosen instrument for the development of the existing Empire air lines, but for Continental lines north of the London–Berlin route the Government will be freed to subsidise the services of another company.

Since the company's formation its machines have flown a total distance in excess of 18½ million miles. It now serves twenty-four countries in four continents and employs over 1800 people spread over fifty stations. Last year its machines used over 2½ million gallons of fuel and carried more than 15 million letters. Counting subsidiary and associated companies, its aircraft fly on the average 17,000 miles a day. The company's air fleet now numbers seven flying boats and thirty-five land planes. Of these forty-two machines, twenty-nine are equipped with four engines each, and nine with three engines. The total horse-power of all the aircraft is 55,620.

Under the company's agreement with the Government, it earns its subsidy by flying each year a fixed minimum number of horse-power miles—that is to say miles flown multiplied by the horse-power of the machine flying them. The European agreement places the minimum figure at 425 million horse-power miles. In 1924–25 the figure attained was about 427 million. In 1934–35 it reached 1665 million. That figure is a tribute not only to the extension of the company's services but also to the increase in the power of the machines by which it maintains them. It is gratifying to note that while the company's net profit is increasing the amount of subsidy which it receives from the Government is decreasing. For the financial year ended March 31st 1934 the net profit was £78,571 of which £20,959 was received as Government subsidy. For the year ended March 31st 1935 the net profit was £133,769 of which £17,464 was received as subsidy.

The machines at present employed on the company's European services are approaching their replacement age and as regards speed are admittedly at a disadvantage relatively to new aircraft. With the future now assured by the provisional agreement with the Government the company has recently placed orders for a large number of new machines which will be larger and faster than the existing main line fleet. Altogether there are now under construction or on order for the company twenty-nine flying boats and twelve land planes. Among the new land planes under construction there is a four-engined monoplane design by Armstrong Whitworth Aircraft, Ltd., which will have seating accommodation for twenty-seven passengers during the day and sleeping accommodation for twenty passengers at night. The flying boats will include a fleet of four-engined monoplane machines being built by Short Brothers which will provide accommodation for twenty-four passengers by day and sleeping accommodation at night for sixteen passengers. There is also under construction a large flying boat with which the company hopes this year to inaugurate a service between England, Portugal, the Azores, and Bermuda with connections from that island to New York and Trinidad. Of even greater interest however is the Mayo composite aircraft illustrated herewith which Short Brothers are building for the company. This combination has been designed to meet the requirements of a direct Transatlantic air mail service. It consists of a flying boat generally similar to the four-engined monoplane boats which, as mentioned above, Messrs. Short are building for the company, together with a monoplane float seaplane driven by four Napier "Rapier" engines. The intention is that the two craft should take off locked together as shown in our illustration and that when flying height has been reached the lock should be released; the float seaplane proceeding to cross the Atlantic while the larger lower unit returns to its base. It is not very clear in what respect the arrangement is superior to one based on flying the long-range machine with a light load of fuel to the requisite height and there refuelling it from a feeder machine before it sets out on its voyage. The fact however that the Air Ministry seems to be officially interested in the experiment—with an eye possibly on the use of a similar combination to facilitate the start of a heavily laden long distance bomber—suggests that the scheme has more aeronautical merits than are obvious at first sight. It is expected that flight trials of the composite aircraft will be begun about August.



IMPERIAL AIRWAYS MAYO COMPOSITE AIRCRAFT

THE BRITISH AIRCRAFT INDUSTRY.

We now proceed to give some brief notes on the work done during the year by certain representative firms engaged in the production of aircraft in this country.

The Fairey Aviation Company, Ltd.—A machine of exceptional interest, the "Fantôme" multi-gun single-seater fighter, was produced by the Fairey Aviation Company to meet a specification of the Belgian Government. The specification called for a top speed of at least 250 m.p.h. and an armament consisting of a 20 mm. "cannon" and four machine guns. This machine, illustrated in the Supplement, is claimed to be one of the most formidable fighting aircraft ever produced. Its primary duty is defence against formations of bombers. The "moteur canon" fires through the hollow airscrew shaft and can discharge shells at the rate of 260 per minute. Two of the 0·303 calibre machine guns are mounted within the lower wings outside the airscrew disc. The two others are disposed within the fuselage alongside the cannon and fire through the airscrew disc with the aid of Constantinescu interrupter gear. All the guns are loaded and cocked by means of compressed air which is also used for operating the trigger motors of the wing guns and for the firing control of the centre guns. The engine is cooled by means of ethylene glycol; the radiator, of honeycomb pattern, is situated in a tunnel beneath the body and between the undercarriage legs. The fuselage structure is composed for the most part of steel tubing. The wing structure is built up of aluminium alloy spars and ribs braced with steel tube struts and is covered with fabric. The undercarriage, it will be noted, is not retractable but the legs and wheels are very fully faired, the outer panels of the legs being readily removed to permit inspection of the shock absorbers and damping mechanism. It is stated that the undercarriage is stout enough to withstand the roughest landing. It will be readily understood that in a machine of such high speed the landing shock even in the hands of a fully skilled pilot may be severe. The equipment of the machine includes electric lighting and heating, wireless transmission and reception and oxygen apparatus. With its high speed, the concentration of fire from its machine guns and the increased range of the cannon, this aircraft will doubtlessly go a long way towards causing a great change in air fighting tactics. At the S.B.A.C. display at Hendon on July 1st the "Fantôme" gave a remarkable demonstration of its qualities.

The Fairey "Hendon" long-range night bomber

to which we have referred in previous reviews was produced in quantity during the year for the Royal Air Force. This machine in its latest form is illustrated herewith. There are three gun stations, at the nose, in the centre and at the tail and when they are manned all the crew are visible to the pilot. As there is complete internal communication throughout the fuselage any member of the crew can in the event of a casualty be replaced while the machine is in flight. The bomber's cockpit at the nose of the machine is protected by a transparent cupola and can be used if required as a navigation station supplementary to the normal navigation station which is situated just behind the pilot and in close proximity to the wireless operator. The bombs are stowed inside the wings and are dropped through hinged doors on the underside. For loading and fusing the bombs access to the racks is provided by means of hinged flaps on the upper side of the wings. A bomb hoist is fitted to enable the bombs to be raised from the ground quickly and with little effort. In addition to its prime duty as a bomber the machine can be used for the transport of troops or for the carriage of spare engines or other heavy equipment.

FAIREY "HENDON" LONG-RANGE NIGHT BOMBER

A third machine on the construction of which the Fairey Company was engaged during the year was the "Swordfish" a general-purpose aircraft designed for torpedo carrying, spotting and reconnaissance duties. Numbers of this design are now being delivered to the Royal Air Force. The machine, illustrated on page 16, is a three-seater the crew comprising the pilot, observer and telegraphist of whom the second named may act as navigator, while the third may leave his seat and assume a prone position for bomb dropping. The bomb and torpedo releasing gear is electrically operated and the control switches at the bomb aimer's station are duplicated in the pilot's cockpit. A jettison switch is provided by means of which the whole load of bombs may be released simultaneously. The pilot has control of a machine gun while a second gun is provided for the use of either of his companions. A feature of the design is the arrangement of the centre section interplane struts. They are crossed to form an inverted V over the body in front of the pilot's seat. During the approach to land or to a torpedo target the normal line of sight lies between these struts. If the pilot, as most pilots do during the final part of a landing, looks over the side the struts do not interfere with his line of sight as they would do if they were arranged in the usual way. The machine has also been produced as a float seaplane.

Westland Aircraft, Ltd.—The Westland Aircraft Works at Yeovil was originally a branch of Petters Ltd. and was managed by the board of directors of that firm. In July the aircraft business was constituted a separate company under the title Westland Aircraft, Ltd., with Sir Ernest Petter as chairman and with Sir Ernest and Captain P. D. Acland as joint managing directors. The new company took over certain shops, machinery, &c., from Petters Ltd. and laid down additional manufacturing accommodation. Since its formation it has been busily engaged on Air Ministry work and has produced a large number of Westland "Wallace II" and Hawker "Audax" machines.

The Westland "Wallace II" illustrated in a Supplement is a two-seater general purpose military machine driven by a Bristol "Pegasus II M" engine. The pilot and gunner are protected by a transparent hood which may quickly be opened to provide exits from the cockpit. As stated in our review a year ago this protecting hood not only promotes the comfort of the crew but actually permits the field of view to be increased and by shielding the rear gun from the slip stream enables it to be operated at the top speed of the machine. The crew's comfort is also promoted by the provision of heating equipment in the cockpit. These details are of very great value when long reconnaissance flights at high altitude are being carried out. It is stated that the protection and heating are such that it is unnecessary for the crew to wear heavy and cumbrous clothing.

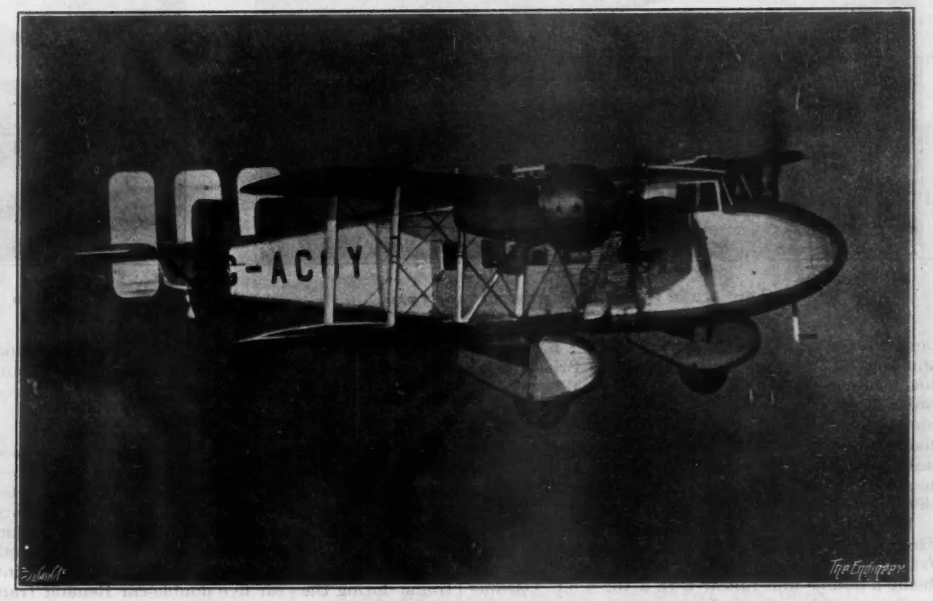
Development work was carried out on the "Pterodactyl" Mark V machine and a single-seater fighter of this type was subjected to Air Ministry official trials. Research and development work was continued on a small two-seater cabin "Autogiro," but some time will probably elapse before this design is marketed.

The Bristol Aeroplane Company, Ltd.—Concerning much of the activity which prevailed and still prevails in the Bristol Company's aircraft shops it is not possible to write fully. During the year the company produced a twin-engined commercial aircraft of very high performance. The same design has been developed as a bomber and it is understood that the company has received a considerable order from the Air Ministry for aircraft of this type. Another machine which made its appearance during the year was the Bristol bomber transport, Type 130, of which we give an illustration in one of our Supplements. This aircraft, it will be seen, is a twin-engined high-wing monoplane. It is driven by two Bristol "Pegasus" III M3 engines. The fuselage, of monocoque construction, and the wings are of metal construction throughout. Hydraulically operated split trailing edge flaps are fitted to the wings. As a bomber the machine carries a crew of four As a transport machine it can carry a crew of three and twenty-four fully armed troops. The machine has a span of 96ft., a length of 67ft. 9in., a height of 16ft., and a gross weight of 18,000 lb.

A. V. Roe and Co., Ltd.—Like other firms in the aircraft industry Messrs. Roe have been and continue to be busy on the supply of aircraft to meet the R.A.F. programme of expansion. In addition they have continued to receive orders from abroad for military and commercial machines, the fulfilment of which, in spite of the home demand, is ensured by the company's determination to maintain its foreign contacts. How important these foreign connections are to the company may be judged from the fact that no fewer than twenty different Governments have now adopted Avro aircraft as standard training machines. The production of such training aircraft continued during the year to provide a considerable amount of work for the company. A new design, the Avro 636, illustrated on page 16, was produced during the year. This machine is particularly intended for the training of pilots who are to proceed to single-seater fighters. It is a high speed two seater. If one of the cockpits is covered in and if a highly supercharged Armstrong-Siddeley "Panther" engine is fitted the machine can be converted into a single-seater fighter of high performance.

In our review twelve months ago we mentioned that the company was building for Imperial Airways two monoplanes to carry eight passengers and a crew of two and to be driven by two Siddeley "Cheetah" engines of 277 h.p. each. These two machines are fitted with retractable undercarriages and are stated to be the fastest aircraft operated by Imperial Airways. During the year a military version of the same design was produced. This machine the Avro 652A or "Anson" is illustrated on page 16. In an unusually short time the type was tried and officially accepted and an order for 174 machines was placed with the firm by the Air Ministry. Several orders for the same design were also received from abroad. In addition to the "Anson" machines the company is busy on the execution of orders from the Air Ministry for Hawker "Audax" and "Hector" aircraft. It continues to build autogiros for the construction of which it holds a licence from the Cierva Company and has supplied a number to several foreign buyers.

Boulton Paul Aircraft, Ltd.—The aircraft department of Boulton and Paul, Ltd., Norwich, was taken over in November 1934 by a separate company, Boulton Paul Aircraft, Ltd. The existing aircraft workshops at Norwich were leased from the parent company as a temporary measure in order to avoid any interruption of output but from the outset it was the intention of the new company to transfer its activities to a more appropriate neighbourhood. Arrangements have now been completed for the erection of a modern aircraft factory at Barnhurst, adjoining the Wolverhampton Municipal Aerodrome. It is expected that the new works will begin production in the coming spring and that the removal from Norwich will be completed by the end of the summer of this year.



BOULTON PAUL "BOADICEA" 7/14 PASSENGER TRANSPORT MACHINE

During January, 1935, the company delivered to Imperial Airways two passenger-carrying machines of the "Boadicea" class. These aircraft of which an illustration is given herewith are designed to serve as feeder machines on routes where traffic is sparse and at the same time to give the passengers the same degree of comfort as they find in the largest liners on the main routes. In addition they are

designed to operate at a much higher cruising speed than that of existing British main line aircraft. They are of all-metal construction and are normally arranged with seats for seven passengers although if no appreciable amount of baggage has to be carried seats for fourteen passengers may be provided. Alternatively the machines may be used for carrying freight or mails only in which case each has a capacity of 410 cubic feet. The engines are two Bristol "Pegasus" III M developing 720 h.p. each at 5000ft. A crew of two and petrol up to 2130 lb. are carried, the total fully laden weight of the machine being 11,300 lb. The maximum speed is 195 m.p.h. at 5000ft. and the range with full tanks, 850 miles.

Apart from these two civil machines, the company's aircraft production was confined to the supply of "Overstrand" twin-engined bombers to the Royal Air Force. These machines illustrated on page 16 are developments of the firm's "Sidestrand" machines which have been in service for some years. They differ from the earlier type in the greatly increased military load which they can carry, in their all-round improved performance and in the fact that they are fitted with a completely enclosed, mechanically operated front gun turret. This turret, visible in our illustration, is claimed to enable the gunner to operate his gun with much greater rapidity and accuracy than is possible in an open gun position. The machine carries a crew of three and a maximum fuel load of 2010 lb. It is driven by two Bristol "Pegasus" II M engines each developing 620 b.h.p. at 6500ft. It has a maximum speed of 155 m.p.h. at 6500ft., a maximum rate of climb of 1250ft. per min. and a service ceiling of 23,000ft. With full tanks its range is 700 miles.

In addition to this production work the firm was engaged on the development of new types of aircraft and new methods of construction.

(To be continued.)

Oil Engine Traction in 1935.

TAKING the world as a whole, the progress of oil-engine traction on railways has been remarkable. Even in England, with its national coal resources and the fact that the railways have not been hit so hard by depressed trade as those abroad, definite progress was registered. As far as can be ascertained, 45 locomotives, 36 set trains, and 300 railcars were delivered throughout the world in 1935.

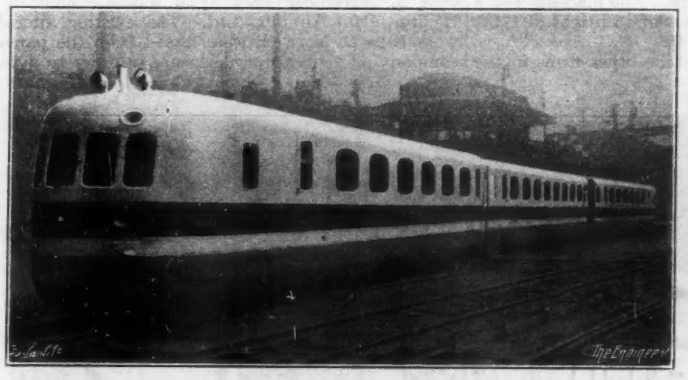
Great Britain and Ireland.

The principal activity of the year was the delivery to the Great Western Railway of thirteen A.E.C. 260 b.h.p. oil-mechanical railcars, three of which had been ordered in 1934 and the remainder in February, 1935. Compared with the 1934 cars working the buffet service between Birmingham and Cardiff, the new vehicles have been improved by the provision of a gear-box for each engine, in place of one geared and one direct drive, and by a strengthening of the underframe. The G.W.R. now possesses one suburban and sixteen fast railcars, and has on order another A.E.C. vehicle of a yet further improved type, which is designed to operate at a much higher cruising speed than that of existing British main line aircraft. They are of all-metal construction and are normally arranged with seats for seven passengers although if no appreciable amount of baggage has to be carried seats for fourteen passengers may be provided. Alternatively the machines may be used for carrying freight or mails only in which case each has a capacity of 410 cubic feet. The engines are two Bristol "Pegasus" III M developing 720 h.p. each at 5000ft. A crew of two and petrol up to 2130 lb. are carried, the total fully laden weight of the machine being 11,300 lb. The maximum speed is 195 m.p.h. at 5000ft. and the range with full tanks, 850 miles.

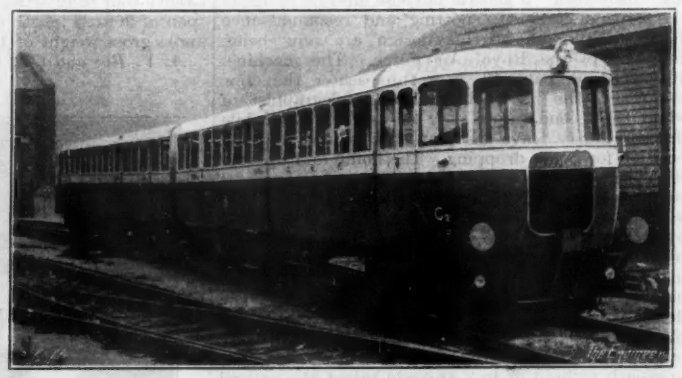
Apart from these two civil machines, the company's aircraft production was confined to the supply of "Overstrand" twin-engined bombers to the Royal Air Force. These machines illustrated on page 16 are developments of the firm's "Sidestrand" machines which have been in service for some years. They differ from the earlier type in the greatly increased military load which they can carry, in their all-round improved performance and in the fact that they are fitted with a completely enclosed, mechanically operated front gun turret. This turret, visible in our illustration, is claimed to enable the gunner to operate his gun with much greater rapidity and accuracy than is possible in an open gun position. The machine carries a crew of three and a maximum fuel load of 2010 lb. It is driven by two Bristol "Pegasus" II M engines each developing 620 b.h.p. at 6500ft. It has a maximum speed of 155 m.p.h. at 6500ft., a maximum rate of climb of 1250ft. per min. and a service ceiling of 23,000ft. With full tanks its range is 700 miles.

In addition to this production work the firm was engaged on the development of new types of aircraft and new methods of construction.

(To be continued.)



NORD 820 B.H.P. NON-ARTICULATED TRAIN



G.N.R. OF IRELAND DOUBLE-UNIT RAILCAR

designed for trailer operation. No other railcars or shunting locomotives were delivered to British main line companies, but, of course, the L.M.S. has on order twenty oil-electric shunters of 350–400 b.h.p. and 50 tons weight, and the G.W.R. one similar machine. At the end of the year Crossley Bros. announced the delivery to a Sheffield steel works of a new type of oil shunting locomotive, which is being developed for all classes of yard work.

In Ireland the suburban service on the Dublin-Howth line of the Great Northern Railway was transferred to oil-engine traction, the vehicle employed being a double-unit railcar with a 102 b.h.p. Gardner engine at each end. Only one of these engines is in use at a time, and the duty is just about as much as one engine can manage, the tight schedules calling for full output nearly all the time. The County Donegal Railway increased its stock of 74 b.h.p. cars by one, and passed an order for another. The two first cars on this railway have covered about 160,000 miles each since 1931, at an overall operating cost, including capital charges, of approximately 4·0d. per mile.

British export activities were more satisfactory. The principal delivery was the two 1300 b.h.p. oil-electric locomotives sent to the North-Western Railway of India for mail service on the Karachi-Lahore route. Actually, these units are intended as an experiment for the conditions on the proposed direct line from Bombay to Karachi, much of which will be across waterless desert. These 113-ton locomotives cost £26,500 each, and it was intended to work them in multiple-unit on the mail trains, but since going out to India three traction motors on one of them have burned out and the other locomotive is being temporarily employed on lighter trains.

Armstrong-Whitworth is now building for the Bombay, Baroda and Central India Railway a 47-ton oil-electric shunter similar to those for the L.M.S., and in the summer a 165 b.h.p. Hunslet geared locomotive was sent to the Sinai peninsula for operation under extremely arduous conditions. Harland and Wolff built a 270 b.h.p. locomotive for the Sudan Government Railways, and this completed the locomotive orders, but the same firm received an order for ten 360 b.h.p. two-stroke engines for installation in oil-engined trains being built by the New South Wales Government Railways. Although the majority of these engines have been built, inordinately lengthy bench tests have prevented delivery. The New Zealand Government Railways have decided to introduce light railcars on various routes, including that over the famous 1 in 15 Rimutaka incline, and fourteen Leyland oil engines and hydraulic torque converters have been ordered for installation in vehicles being built in the railway shops. Over twenty railcars or power sets are now under construction in this country for British-owned South American railways.

France and Belgium.

The six big French railways continued to go ahead with full throttle, and now have over 230 oil-engined railcars in service, with several uncompleted orders totalling over fifty vehicles, and including three Renault double-engined trains of 1000 b.h.p., which will have mechanical transmission—a distinctly unusual feature for this power. The P.L.M. put into traffic during the year five double-car Renault trains of 500 b.h.p., one of which was shown at Brussels Exhibition before going to the purchaser, and the same railway has ordered nine cars to be powered by a new 300 b.h.p. twelve-cylinder V type Saurer oil engine. The Nord is now taking delivery of some 265 b.h.p. Renault cars and of eight 820 b.h.p. triple-unit Maybach-engined trains similar to the two which have been running on 63–65 m.p.h. schedules between Paris, Lille, and Tourcoing since July, 1934. These two sets have given very regular service, but they are not worked hard, as one rake is normally held in reserve while the other makes a 350-mile round trip per day. Since going into service new pistons of a different material have been fitted, the fuel pumps altered, and the suspension of the power bogies modified. Operating costs collected from about forty four-wheeled and thirty double-bogie oil-engined cars of half-a-dozen makes in France show an average of 11½d. per mile, including everything, for the small vehicles, and 13d. for the bogie cars.

Only two or three cars were put into service on the lines of the Belgian National Railways in 1935, but useful experience was gained with the two dozen cars already at work. The 410 b.h.p. Maybach streamlined articulated set maintains a 60·9 m.p.h. non-stop service between Brussels and Ghent—six trips a day—at an operating cost of 6½d. per mile (at the present exchange rate), this figure including maintenance and repair, but not financial charges. Nine 820 b.h.p. streamlined trains are being built, and also a couple of 300 b.h.p. single vehicles.

Germany.

World-wide interest was aroused by the introduction of thirteen two-car trains of 820 b.h.p. modelled on the famous "Flying Hamburger," for the first two of them, the "Flying Cologner" and the "Flying Frankfurter," are each booked for part of their journeys to make start-to-stop runs at 80·3 to 82·7 m.p.h., the first time the 80 mark has been exceeded in the history of railways. Fast oil-engined train services are now run between Berlin and Hamburg, Berlin and Cologne, Berlin and Frankfurt (also serving Leipzig), Berlin and Dresden, Cologne and Hamburg, and Munich and Berlin. The "Flying Cologner" set runs 720 miles a day and the "Frankfurter" set 668 miles. Three new triple-car trains of 1200 b.h.p., with Voith hydraulic transmission, have been built, the engines being the ordinary Maybach 410 b.h.p. unit with cylinders increased by 10 mm. in diameter, and supercharged up to 600 b.h.p. by a Brown-Boveri blower, the speed remaining at 1400 r.p.m. The Reichsbahn railcars of 150 to 410 b.h.p., of which there are over 150, average 93,000 miles between heavy overhauls. Once more the Reichsbahn has decided to experiment with large oil-engined locomotives, and has acquired for mixed service a 1300 b.h.p. 2–6–2 type supercharged unit with hydraulic transmission.

Scandinavia.

Denmark staged one of the greatest oil-engine attractions of 1935 by the widely advertised appearance of the Lyntog, or Lightning Trains, three-car sets with four Frichs engines totalling 1100 b.h.p. These trains have enabled accelerations of about 2½ hours to be made in the existing 7-hour schedules between Copenhagen and Esbjerg and Copenhagen and Aarhus. Since going into traffic in May, the Lyntog sets have been operated at a fuel cost of only 1½d. per mile; the wages of the driver amount to about 1½d. per mile, and the Danish State Railways do not expect the total operating cost, including the wages of the driver, assistant driver, and guard, repairs and maintenance, and financial charges, to exceed 10½d. per mile if the sets can be run for at least 65,000 miles a year. Ten new 550 b.h.p. oil-electric railcars have just been ordered specifically for operating suburban traffic on the non-electrified lines round Copenhagen. In Norway the single 270 b.h.p. oil-mechanical car in service still works the slow train to Hell (a small station near the Swedish frontier), and further cars to the same design are on order. New oil-electric cars of 220 b.h.p. have been introduced in Sweden, where the first oil-electric car in the world still wends its 18-mile way up and down the Mellersta-Sodermanlands Railway, with a mileage of some 800,000 to its credit since 1914.

Central Europe.

Considerable progress has been made in the adaptation of light oil-engined cars to railway work in Czechoslovakia, Austria, and Hungary, without the introduction of any new type with startling characteristics. In all three countries the general practice is to have a railcar pulling two or three light trailers, and in Czechoslovakia one of the main Prague–Bratislava expresses is worked by a 300 b.h.p. oil-electric railcar pulling trailers. The operating cost of 150–180 b.h.p. cars hauling a trailer is 10½d. per train-mile, which include amortisation and repairs, the former amounting to 4½d. per train-mile.

In Hungary the Ganz car is universal, and the 275 b.h.p. model now runs a daily international service between Budapest and Vienna at an overall speed of 56 m.p.h. Branch line cars of 120–150 b.h.p. have shown operating costs of 7¾d. per mile in slow

service with a yearly mileage of 35,000 per car. This figure includes maintenance and the cost of a heavy overhaul after a mileage of 67,000, but not financial charges. Further south, in Bulgaria, oil-engined units were tried for the first time in 1935; while further north, in Poland, experience with Thornycroft, Saurer, and Ganz cars has led to proposals for the construction of oil-engined vehicles for fast long-distance work. Roumania, after experimenting with a few small 150 b.h.p. cars, has gone in for similar units on a large scale, and is also building some big double-engine cars of 300 b.h.p. with Mylius mechanical transmission, which are to be suitable for a top speed of 75 m.p.h., 13 m.p.h. faster than the present limit for steam locomotives.

Italy and Spain.

Three most interesting features have characterised the progress of the oil engine on the Italian State Railways during the past twelve months. First, the delivery of forty-three single-unit high-speed Breda cars, each powered by two British engines (A.E.C., 130 b.h.p.), with British transmission (Wilson epicyclic gear-box), and heated by British equipment (Clayton-Dewandre heaters). One of these cars has attained a speed of 100·6 m.p.h. Secondly, an order was placed for four triple-car articulated *de luxe* trains with two 400 b.h.p. Fiat engines and mechanical transmission, which are to be used on the Milan–Venice and Milan–Bologna routes. Thirdly, the first rack railway vehicle to be driven by an oil engine was built, and put to work on the Strade Ferrate del Mediterraneo. This unit, and others which have followed since, are small railcars of 100 b.h.p., but with the high ratio of 15 b.h.p. per ton of tare. They are fitted with both rack and adhesion drives, the former being used on numerous gradients of 1 in 10 to 1 in 15 and the latter on gradients of 1 in 16 and flatter.

The greatest proportional development in oil-engine traction has taken place in Spain, where at the end of 1934 there were only six railcars at work. Now there are twenty-six railcars and two shunting locomotives, and, in addition, there are on order for early delivery no fewer than thirty cars in powers of 100 to 410 b.h.p., four streamlined four-car trains of 1460 b.h.p., and two three-car sets of 1100 b.h.p. Two of the bigger trains are to be used for the Sud Express *de luxe* service between Madrid and the French frontier at Hendaye, and it is expected that the higher speed at which they will climb the numerous long gradients, and round the frequent curves, will enable the schedule to be reduced from the present 11½ hours to 8½ hours. The other trains are to be used on the lines from Madrid to Santander, Gijon, Corunna, and Vigo, on daily runs up to 518 miles. The single-unit cars on order include French, Italian, Hungarian, and Danish types, and all, except the Danish vehicles (260 b.h.p.) will have mechanical transmission.

Africa and The East.

One of the orders which aroused most interest in British circles was that for ten 275 b.h.p. railcars with air-conditioning equipment, which was placed by the Egyptian Government Railways in 1934 with Ganz, of Budapest. These cars were all delivered in the course of 1935, and are operating on the new direct line from Cairo to Suez, from Cairo to Barrage, and from Bab-el-Louk to Helwan. These cars cost £E 7585 apiece, and they are designed to carry seventy passengers at a top speed of 68 m.p.h. In the design of the engine, transmission, bogies, and underframe, they are similar to the Ganz car, known as the Arpad, working between Budapest and Vienna, and the engine and gear-box are mounted directly on one of the two bogies. Close by, in Syria, four French-built cars of 220 b.h.p. were set to work on the Damascus-Hamah Railway. They are powered by the Junkers type of two-stroke, opposed-piston engine, and have four-speed Mylius gear-boxes and wheels with rubber cushioning blocks.

On the newly opened Congo-Ocean Railway, in French Equatorial Africa, three heavy oil-electric locomotives are at work on gradients of 1 in 45 combined with 330ft. curves. They are noteworthy in being amongst the first supercharged locomotives to go into regular operation. The normal unsupercharged capacity of the M.A.N. engine is 650 b.h.p. at 700 r.p.m., but the continuous supercharged output is 825 b.h.p. at the same speed, and the one-hour rating is 950 b.h.p. at 700 r.p.m. The Rateau blower is driven by the oil-engine exhaust gases. The Rhodesia Railways have ordered a 300 b.h.p. oil-mechanical railcar from Ganz, but elsewhere in Africa there has been little activity, except a French grant of 1,100,000f. for the purchase of railcars by the Ivory Coast Railways, and a spirited Press campaign in Kenya to induce the Kenya and Uganda Railways to adopt railcars.

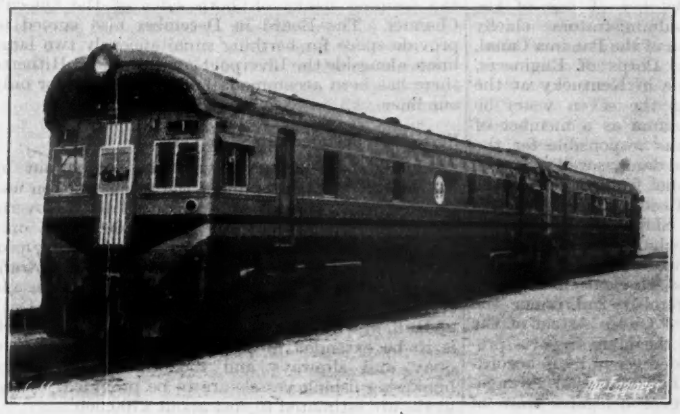
Nor have things been much busier in the East. In India, the Madras and Southern Mahratta Railway set to work six 160 b.h.p. cars, the bodies of which were built in the company's own shops, and the engine sets and electric transmission supplied by Armstrong-Whitworth. The Armstrong-Whitworth 1300 b.h.p. locomotives for the North-Western Railway have been mentioned already, and the only other Indian unit was a 325 b.h.p. oil-electric shunter acquired by the Tata Iron and Steel Company. Elsewhere, new vehicles were confined to two or three small cars on the Manchukuo State Railways, and to six four-car oil-electric train sets introduced on the Dairen-Mukden main line of the South Manchuria Railway. Four of these rakes are provided with 500 b.h.p. Sulzer engines of a new lightweight design, and the other two have Japanese-built power equipment. An order has been passed for oil-mechanical cars for Indo-China, and the Japanese State Railways are to introduce streamlined oil-electric trains between Tokyo, Kobe, and Osaka, but these proposals are not yet beyond the drawing-board stage.

South America.

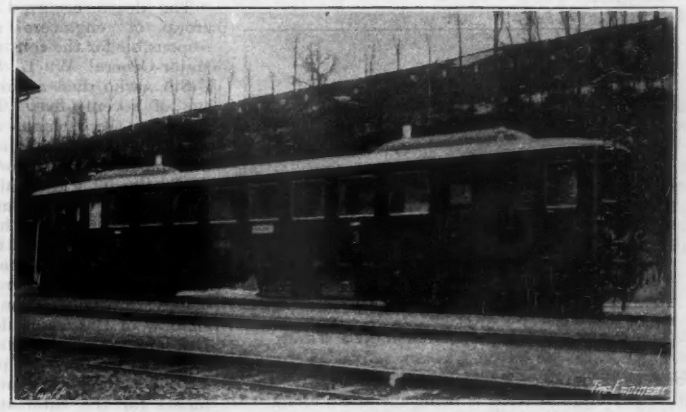
Despite the flying start made by the Buenos Aires Great Southern Railway in the years 1929–32, oil-engine traction has fallen off in pace during the last two years, and the only delivery recorded in 1935 was that of the four 270 b.h.p. cars built by Sulzer for the Buenos Aires Provincial Railways. The order which the Argentine Government Railways placed with Ganz in December, 1934, for eighteen oil-mechanical railcars, has been increased to thirty-four vehicles, and orders for much new equipment were placed with British builders for delivery in 1936. These, taken in conjunction with the satisfaction given by the units in service, as expressed by Sir Follett Holt at the recent annual meetings of British-owned Argentine railways, indicate that oil-engine traction has a healthy future in South America. Sir Follett Holt mentioned, *inter alia*, that the 450 b.h.p. Armstrong-Whitworth unit sent to the Buenos Aires Western Railway in 1934 had covered 120,000 miles without repairs to the oil engine having been necessary. An order has been placed with the Fiat company for a number of Littorina railcars for the Central Railway of Brazil, some of which are to have petrol engines and some oil engines.

North America.

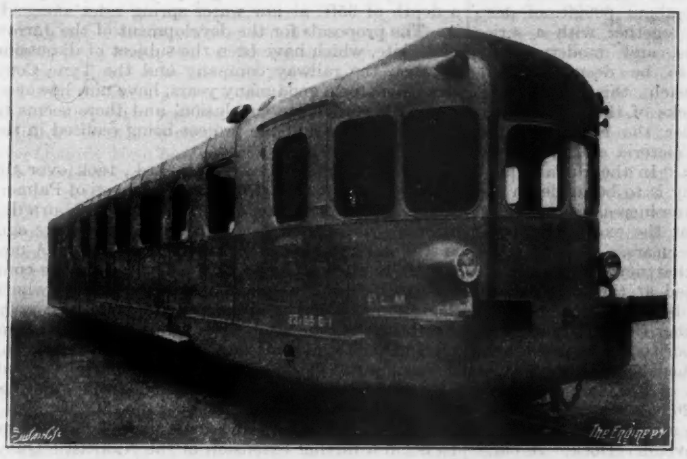
The spate of streamlined set trains which began in 1934 with the Burlington Zephyr was continued throughout 1935, and shows no signs of abating, for although only two more trains are actually under construction at the moment, orders for several more are pending. Two more Zephyr trains were introduced by the Chicago, Burlington and Quincy Railroad for service between Chicago and the Twin Cities (St. Paul and Minneapolis), over which route each train is making a daily mileage of 862 at an average speed of 66 m.p.h. Such is the confidence of the owning company, that there is no reserve, and if any defects occur a steam train is marshalled, and run as close as possible to the schedule of the oil train. A similar four-car set, named "Mark



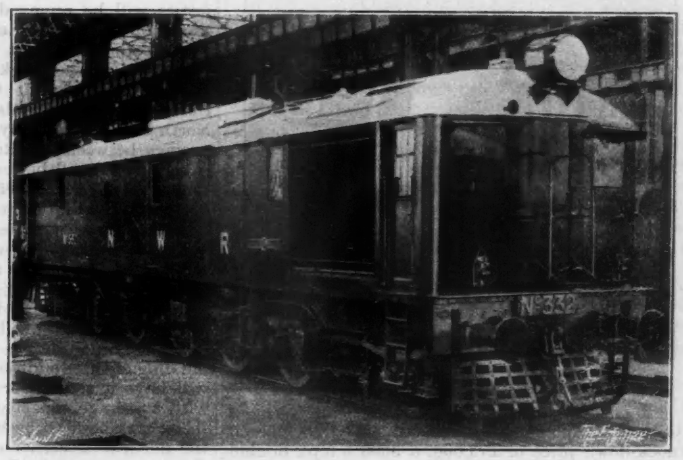
3600 H.P. LOCOMOTIVE FOR ATCHISON, TOPEKA AND SANTA FE RAILROAD



TYPICAL CZECHOSLOVAK RAILCAR



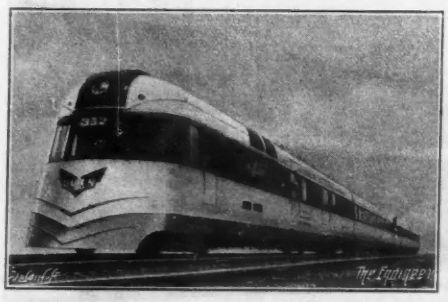
250 B.H.P. RENAULT RAILCAR



1300 B.H.P. OIL-ELECTRIC LOCOMOTIVE FOR INDIA

Twain," has been introduced on another of the Burlington's main lines, that from Burlington to St. Louis, and fourth cars are being built for insertion in the three-car rakes of the Chicago-Twin Cities trains, and also for the original Burlington Zephyr, which is still making a daily mileage of 500 between Lincoln and Kansas City. Taken over the 100,000 miles of its regular service, the first Zephyr has shown an operating cost, including maintenance and the wages of the complete train crew, but excluding capital charges, of 17d. per train-mile.

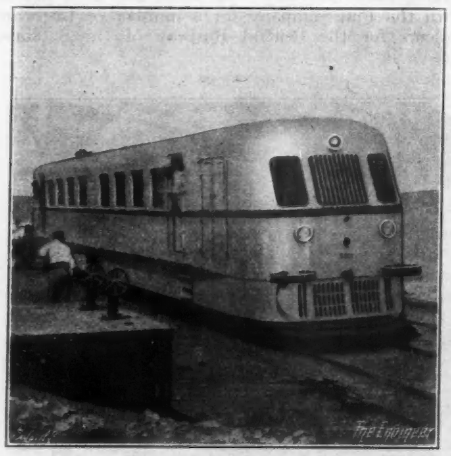
The six-car Union Pacific train, which made the record run between Los Angeles, Chicago, and New York, has been rebuilt as a seven-car set, and the original 900 b.h.p. Winton two-stroke engine replaced by one of 1200 b.h.p. It has been christened "City of Portland," and is now working a Pullman-sleeper service between Chicago and Portland, Oregon, the distance of 2272 miles being covered at an average of 57·1 m.p.h., inclusive of twelve stops, this speed being far above that of any other train making a



LATEST AMERICAN STREAMLINED TRAIN

four-figure mileage. The 900 b.h.p. engine taken from the original train is being installed, along with a sixteen-cylinder, 1200 b.h.p. engine, in a new eleven-car set for the Union Pacific Railroad, but this total of 2100 b.h.p. is being surpassed by the two 1200 b.h.p. Winton engines which are being incorporated in yet another eleven-car train for the same railway. Other streamlined oil-engined set trains put to work in the U.S.A. during 1935 are the 800 b.h.p. "Comet" on the New York, New Haven and Hartford Railroad; the "Flying Yankee," a three-car Zephyr-type train on the Boston and Maine Railroad, and two three-car non-articulated trains named "The Rebel" on the Gulf, Mobile and Northern Railroad, which are unusual in that a fourth car is brought into the formation twice a day over certain parts of the run. A daily mileage of 5300 is now covered by the nine super-speed oil-engined trains in the United States.

Different ideas as to the efficacy of the set train are held by the Atchison, Topeka and Santa Fe



275 B.H.P. RAILCAR FOR EGYPT

Railroad, which has purchased, at the scarcely knock-down price of £73,000, a 3600 b.h.p., double-unit, oil-electric locomotive weighing 215 tons, for hauling its new luxury train, "The Super Chief," between Chicago and the Californian Coast. This locomotive is really two 1800 b.h.p., double-bogie units coupled together, and either can be used alone. Actually, another 1800 b.h.p. set of exactly the same design is being experimented with by the Baltimore and Ohio Railroad. Other locomotive activities in the U.S.A. include the building of 1800 and 2000 b.h.p. locomotives for short-distance freight traffic for the Illinois Central Railroad, and a number of shunting units of standard 300–800 b.h.p. designs. Railcars of 265 b.h.p. have been acquired by the Seaboard Air Line, a double-engine railcar-train of 600 b.h.p. by the Baltimore and Ohio, and two 800 b.h.p. oil-electric railcars by the Boston and Maine Railroad.

IT has been officially announced by the English Steel Corporation that the works of Darlington Forge, Ltd., are to be reopened. These works were closed down in 1932 during the depression.

Harbours and Waterways in 1935.

No. I.

THERE is relatively little to record of important dock and harbour works begun or completed in the United Kingdom in the year 1935, and, judging by the Bills of which notice has been given in the present Session of Parliament, it does not appear that any works of considerable size are likely to be begun in the near future. A very small part of the thirty million pounds to be expended by the railway companies on the development schemes, for which funds will be provided out of a Government guaranteed loan, will be allocated to the railway-owned docks. In foreign lands, however, progress in port development, and especially in the construction and improvement of inland navigable waterways, has been at least as marked as in any recent year.

The death occurred in October of one of the group of engineers and administrators chiefly responsible for the construction of the Panama Canal, Major-General W. L. Sibert, Corps of Engineers, U.S.A., who died at his home in Kentucky at the age of seventy-five. During the seven years he spent on the Isthmus of Panama as a member of the Canal Commission, he was responsible for the building of the Gatun locks and dam, as well as for the excavation of the canal channel from Gatun to the Atlantic. Henry Ashman Reed, for many years engineer to the Manchester Ship Canal Company, and later a member of the Technical Advisory Committee of the Suez Canal Company, died in January.

The sixteenth International Navigation Congress opened in Brussels on September 2nd under the shadow of the tragic death of Queen Astrid of the Belgians. The discussion of the many reports presented to the Congress proceeded generally in accordance with the programme, but all social arrangements for the entertainment of delegates were of necessity abandoned. We published in recent issues of THE ENGINEER* abstracts of several of the reports presented to the Congress. The subject which attracted the greatest attention was that covered by a group of papers on the design of breakwaters with vertical sides and the effect of wave action thereon. Recent failures of breakwaters of the vertical type and the valuable investigation of wave pressures by means of instrumental measurements carried out at Genoa provided material for a discussion at this international meeting of harbour engineers which was of more than ordinary importance.

THE UNITED KINGDOM.

The Port of London.

The Port of London Authority announced early in the year that a scheme of improvement at the Royal Albert and Royal Victoria docks, involving an expenditure of upwards of £1,750,000, was about to be undertaken. Parliamentary authority for these works was duly obtained and construction has already begun. In the Royal Victoria Dock, which was built in 1855, a number of old and obsolete jetties will be removed and about 6000ft. of deep water quayage constructed, together with a series of two-storied transit sheds, and modern quay equipment. The dock is to be deepened from 28ft. to 31ft., and, to reach this depth, the tunnels which carry the tracks of the London and North-Eastern Railway under the communication passage between the Royal Victoria and the Royal Albert docks will be lowered. In the Royal Albert Dock a new quay 5350ft. long is to be made on the north side and the depth of water increased from 29½ft. to 34ft. It is estimated that the execution of the scheme will occupy about five years.

We recorded a year ago that new timber-storage sheds were then being erected at the Surrey Commercial Docks; these have been brought into use, but the demand for still further timber accommodation has induced the Authority to authorise the building of three additional sheds for soft wood which will have a total floor area of 219,000 square feet with a storage capacity of 20,000 tons. These new sheds are about to be begun and will be situated at the north-west corner of Lavender Dock. A barge channel or canal 600ft. long is to be made between the sheds to enable a number of barges to be unloaded simultaneously. This scheme, as well as the larger scheme sanctioned by Parliament for the Royal Docks group, involves a considerable amount of remodelling of roads and railways. At the Surrey Commercial Docks additional accommodation for cold storage has recently been provided.

One section of the flood relief works carried out at Stratford by the Lee Conservancy Board and the West Ham Corporation at a cost of about £600,000 was officially opened on October 16th by Mr. Hore-Belisha, the Minister of Transport. These works were begun early in 1931 and, in addition to providing for flood relief, certain back-waters of the river Lee have been opened to navigation and other navigable channels improved.

The Mersey and the Manchester Ship Canal.

The Manchester Ship Canal Company recently celebrated the fiftieth anniversary of the passing of the Ship Canal Act on August 6th, 1885; but it was not until May 21st, 1894, that the Canal was formally opened by Queen Victoria.

The second of the two sand pump dredgers recently built by Cammell, Laird and Co., Ltd., of Birkenhead, for the Mersey Docks and Harbour Board, the "Hoyle," was brought into service during the year. This dredger, like her sister ship, the "Hilbre Island," dredges to a depth of 70ft. below water line, and can load 3500 tons of sand in fifty minutes. The work of extending the training banks and revetments in the sea channels of the Mersey is proceeding steadily. In September the Mersey Docks and Harbour Board decided to put in hand immediately a further extension for about 1800 yards seaward of the training banks on both sides of the Queen's Channel. The Board in December also agreed to provide space for berthing simultaneously two large liners alongside the Liverpool landing stage. Hitherto there has been accommodation at the stage for only one liner.

North-East Coast and Humber Ports.

Among the works proposed to be carried out by the railway companies under the reconstruction and improvement schemes to be financed by a Government guaranteed loan of £30,000,000, the only important items relating to ports are works for providing additional accommodation for the fish trade at the Hull and Grimsby docks of the London and North-Eastern Railway. The St. Andrew's Dock at Hull, in which is centred the fish trade of the port, is to be extended in a westerly direction. A new quay and slipways and modern equipment for bunkering fishing vessels are to be provided. These works are estimated to cost about £700,000.

The training walls at Trent Falls, the confluence of the rivers Ouse and Trent, which the Aire and Calder Navigation began to make about seven years ago, are now finished. About £200,000 has been spent on these river improvement works, to the cost of which the Humber Conservancy Commissioners contributed.

The London and North-Eastern Railway announced in July that it has been decided to reconstruct the west quay at Tyne Dock and at the same time to renew the crane equipment at a total cost of about £180,000. The new coal-shipping staiths at Hebburn, which are being built by the Tyne Improvement Commissioners at a cost of approximately £162,000, are expected to be brought into use during the early summer of 1936. In March Mr. P. Malcolm Stewart, the Special Area Commissioner, offered a grant of £250,000 towards the cost of the scheme for constructing quays at Jarrow Slake subject to the London and North-Eastern Railway and the Tyne Improvement Commissioners coming to an agreement as to the future use and ownership of Tyne Dock. The scheme provides for building a quay 1400ft. long with a depth of 35ft. at low water spring tides alongside it. The proposals for the development of the Jarrow Slake site, which have been the subject of discussion between the railway company and the Tyne Commissioners for a good many years, have not, however, reached any definite conclusion, and there seems to be little prospect of the project being realised in the near future.

In April Vickers-Armstrongs, Ltd., took over the ship-repairing yard and dry dock business of Palmers Hebburn Company, Ltd., including the Hebburn dry dock, which, although constructed many years ago, is still the largest on the North-East Coast. A new wharf, 450ft. long, is to be constructed by the company at Hebburn as an extension of an existing wharf, 250ft. long, for use as a repairing and fitting-out jetty. Hawthorn, Leslie and Co., Ltd., have just completed the work of widening, lengthening, and deepening the dry dock at their Hebburn shipyard. The dock is now 503ft. long and 66ft. wide, and has a depth at high water of 24ft. over the sill.

The Corporation of Newcastle-upon-Tyne is about to begin a further extension of the Newcastle Quay. This will be 700ft. in length and will be built downstream of the last extension, which was brought into use in December, 1933. The new quay will have behind it a large flour mill to be constructed by Spillers, Ltd.

The River Wear Commissioners propose to reclaim some 60 acres of foreshore and sea bed adjoining the South Docks at Sunderland, at a cost of £350,000, and to utilise the land for timber storage purposes. The Blyth Harbour Commissioners are increasing the area of deep-water accommodation in the upper harbour by dredging and other works. It is expected that the extension will be completed early in 1937, when about 4½ acres of water space having a low-water depth of 24ft. will have been added to the harbour area. The coal shipments at Blyth in 1935 have approximated to the record export of 1934, when 6¼ million tons were shipped at the staiths.

Southern Railway Ports.

All the transit sheds, eight in number, which extend for a distance of 1¼ miles along the deep-water

* Sept. 13th, 20th, Oct. 11th, and Nov. 8th, 1935.

quay at Southampton, have now been completed and are in use. In order to ensure the safety of the liner "Queen Mary" when she arrives, as is intended, at Southampton in May next, the Harbour Board has undertaken the extension by dredging of the lower turning area near the Ocean Dock at Southampton. This work is in addition to the deepening, widening, and straightening which the Board has been carrying out in parts of the navigable channel between Southampton and the Solent. A radio beacon, established by Trinity House, was brought into service at the Nab Tower in the approaches to Spithead on December 9th.

The special berth now being made at Dover for the accommodation of the Southern Railway Company's cross-Channel train ferry service between that port and Dunkirk is still far from being completed, the contractors having encountered great difficulties in building the walls and floor of the small closed dock intended for the train ferries. The inflow of water from the fissured chalk foundation proved to be immensely greater than had been anticipated. The dock is to be operated in the manner of a lock, the level of the water in it being raised or lowered as required so as to bring the rail tracks on the ferry boat approximately to the same level as those on the shore. The three ferry boats, built by Swan, Hunter and Wigham Richardson, Ltd., were all completed in the course of the year 1934, and, except for occasional special services on which some of them have been engaged, they have been lying at Southampton for over a year, awaiting the completion of the works at Dover. The railway company has recently announced that the service will begin running some time in the present year. The terminal at Dunkirk is ready for the reception of the ferry traffic.

Scotland.

In July the Clyde Navigation Trust approved a scheme of dock extension, which is estimated to cost about £7,000,000. This project includes the provision of about 4½ miles of additional deep-water quays on the south bank of the river, extending along a frontage of about 1½ miles. Two basins would be constructed westward of the King George V Dock, with dry docks at the southern end of the lower basin, and it is proposed to widen the Clyde near Renfrew, the additional width to be provided being as much in one place as 200ft. The deepening and widening of the channel below Clydebank in preparation for the passage down the river of the "Queen Mary" has been in progress during the year, and is now nearing completion.

Inland Waterways of the United Kingdom.

The Grand Union Canal Company announced in September that it proposed to construct a fleet of over 150 barges capable of navigating the tidal Thames to receive or deliver cargoes direct over ships' sides. These new barges are being put into service in pairs, one of each pair being self-propelled, and capable of towing the second dumb craft.

EUROPEAN PORTS AND WATERWAYS.

France.

The new *Gare Maritime*, which has been built on the Oblique Mole, one of the three quays at Havre of the Compagnie Industrielle Maritime, was brought into use in April, and the installation of cranes and other equipment on the quay is now practically finished. It will be recalled that the berths alongside the Oblique Mole have a depth of water of 14 m. at low water of equinoctial tides.

The petroleum imports through the C.I.M. depôt at Havre in 1934, the last year for which figures are available, exceeded two million tons, double the quantity imported during the preceding year.

The deepening of the harbour channel and approaches at Havre and the removal of the old South Pier in the outer harbour simultaneously with the construction of the new pier on the south-west side of the enlarged harbour, are still in progress. Nearly the whole of the old pier has now been demolished and a depth of 9·5 m. below zero has been attained throughout the channel, which is now being dredged to 10·8 m.

The Ateliers et Chantiers de la Loire are building at their Saint-Nazaire yard a construction dock which combines the functions of a building berth and a basin into which the hull can be floated for completion. The dock is being constructed parallel with the Loire entrance channel and a passage is to be cut between it and the channel to permit of a completed ship being taken into the river. The floor of the dock will be at two levels. A hull when ready for floating will be moved from the building berth into the deeper basin alongside over a dividing wall, the whole dock being flooded to maximum level for this purpose. The water having again been lowered, leaving the hull afloat in the basin, the building berth will be available for further work. The dock is designed for ships up to 300 m. long, and primarily for building battleships of 35,000 tons.

The building of the viaduct and island mole for ocean traffic at La Pallice has been suspended for some time, owing to financial difficulties, but efforts are now being made which, if successful, will enable work to be recommenced.

The first section of the port extensions at Dunkirk, which we described in a series of articles in this journal in March last, has now been virtually completed. The superstructure of the new west jetty is finished. The building of the turning basin and No. 6 basin, which will form an extension of the old system of docks, has not yet been begun.

At Boulogne the large barge-loading bucket dredger, "Pas-de-Calais II," built in 1933, is now engaged in deepening the channel through the outer harbour to the intended depth of 13 m. below low-water datum. This powerful craft can dredge at a depth of 75ft. below the water line. The construction of the Digue Carnot, which forms the principal protection to the new outer harbour at Boulogne, has reached the pier head, the caissons for which were placed in position about a year ago. The north mole, which will ultimately complete the protection of the new outer harbour at Boulogne, has been begun.

At Marseilles the Bassin Mirabeau at the western end of the port is still under construction. The new mole which forms part of the Mirabeau extension will have 750 m. of quayage on one side and 930 m. on the other side of it. All the quay berths at this mole have a minimum depth of 13 m. In the meantime the outer breakwater is being slowly extended in a north-westerly direction parallel to the Bassin Mirabeau. The present extension, in a depth of about 35 m., is in the form of a vertical wall of cyclopean blocks set on a rubble mound at 12·0 m. below tidal zero. The weight of the individual blocks now being used is 450 tons instead of blocks of 350 tons as used in the first section of the extension. The Bassin Joliette at the eastern end of the dock area is being remodelled by building inclined moles each 277 m. long. This is a part of the improvement now being carried out in the port of Marseilles for the accommodation of the larger ships now under construction for the North African trade.

We have from time to time referred to the important work of dredging a channel across the sea-bar of the river Gironde. The width and depth of the bar channel have now been somewhat increased since we described the dredger "Pierre-Lefort" in our issue of April 7th, 1933. This powerful suction dredger was engaged for some time during the winter of 1934–35, before the s.s. "Normandie" left St. Nazaire, in deepening by over 3 m. the outer channels of the Loire estuary in order to enable the ship to reach the sea.

The third of the series of storage reservoirs, which are intended for the regulation of the dry-weather flow of the navigable Seine, is about to be begun. The capacity of this reservoir, at Champaubert, will be about 23 million cubic metres, which is the equivalent of the combined capacities of the Crescent and Chaumeçon reservoirs already in service. The fourth reservoir, to be built later at Pannevière, will have a capacity of about 85 million cubic metres.

Belgium.

A further section of the Albert Canal, which will, when completed, provide a waterway for large barges of the Rhine type connecting the Meuse below Liège with the Scheldt at Antwerp, was inaugurated by the King of the Belgians and the late Queen Astrid on May 13th. The canal, begun in 1930, is now about two-thirds finished, the most recent section to be opened to traffic being one about 25 kiloms. long near the Antwerp end. The canal has a length of 146 kiloms., and when it is completed, probably in 1937, there will be six locks only between Liège and Antwerp docks. We published a description of this important work in our issues of May 17th, 24th, and 31st, 1935.

Germany.

The navigable channel of the lower Weser has now been deepened to give a minimum depth of 11·0 m. on an average low water over a channel width of 300 m., and at Bremerhaven a depth of 12·3 m. at low water has been provided in the roadstead, and at the Columbus quay used by the principal Trans-atlantic liners. The Kaiser Wilhelmhafen at Hamburg has also been deepened to 10 m. at low water and 12·2 m. at high water.

Spain.

A new dry dock is now being built at Cadiz, and at Carthagena an existing naval dry dock is being lengthened to take warships of up to 205 m. in length. In making this extension the Spanish engineers are using monoliths for the side walls of the dock in similar fashion to the monolith construction employed in building the large dry dock at Tilbury a few years ago.

The vertical wall breakwater at Valencia which was destroyed in a storm in 1928 has now been reconstructed in the form of a mound breakwater protected on its seaward face by large concrete blocks.

(*To be continued.*)

Roads, Bridges and Tunnels in 1935.

No. I.

THE rapidly increasing importance of the road systems of all developed countries is in no way more clearly demonstrated than by the reasons for the construction of modern bridges and tunnels. Whereas in the nineteenth century hardly a single bridge or a single tunnel of any magnitude was constructed which did not carry a railway, to-day almost all the major schemes of this character have been advocated and finally adopted with the primary object of shortening road routes between important centres. It is easy to quote examples. There are the two great bridges under construction in San Francisco, the projected tunnel under Mont Blanc, the Mersey Tunnel at Liverpool, the Sydney Harbour Bridge—all vast and expensive undertakings. In this country alone mention can be made of several schemes, among which are those for a bridge across the Forth at Queensferry, and a tunnel under the mouth of the Tyne. But the tendency to give increased importance to the road is not confined to expenditure on bridges and tunnels. In the national Budgets of most nations expenditure upon the development of roads in general, a term which includes minor works of a different character, bulks largely. In this country, for instance, one of the attractive "planks" of the "National" Government during the recent General Election was the promise of a £100 million five-year plan for the development of the road system. So important, in fact, is road transport becoming as a means, not only of internal communication, but for the purposes of international trade that groups of Governments have agreed in general upon the construction of grand trans-continental highways, such as that from Paris and London to Constantinople, and another in the New World to run from Canada to South America.

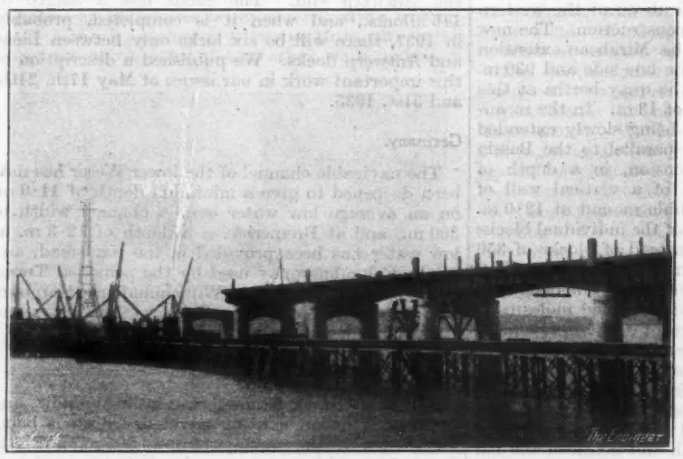
All this development and planning on the grander scale is additional to research work undertaken with the object of making roads safer for those that use them. The coming into favour for arterial highways of the twin road construction in which the streams of traffic flowing in opposite directions are separated from one another can be discerned. In Germany, the growing of a hedge between the roads is advocated with the object of overcoming the problem of head-lamp glare and in this and many other countries the further sub-division of the roadway into cyclists' tracks and pedestrian footpaths is being tried. At road junctions Europe has not as yet been driven to the expensive American expedient of "fly-over" bridges, but roundabouts and traffic signals sometimes combined with swan-necked approaches to slow up the traffic automatically have proved their worth. In towns, besides the relief of congestion, the great problem is provided by the pedestrian. Elsewhere he has been rather more subservient to the motorist, but in this country he still maintains his ancient right to use the King's highway as he pleases. Although the introduction early last year of a 30 m.p.h. speed limit in built-up areas has not, as its opponents suggested, unduly delayed the flow of traffic and has, it seems, undoubtedly contributed to a reduction in the number of road casualties, the success of the Belisha crossing is more doubtful. From the first the pedestrian never wholly trusted the motorist to give him free passage, and now the law at the crossings appears to be as much honoured in the breach as in the observance.

Except for the coming into force of the restrictive legislation already commented upon, the year 1935 was not notable for legislative action. It was a year for marking time and for noting what effect earlier changes of the law had brought about. On the whole, the result of heavier taxation of commercial vehicles on a basis of unladen weight has not been wholly unbeneficial when combined with enforcement of the law against overloading, for it has resulted in the development by manufacturers of chassis of much lighter weight in proportion to their strength. Though the much stricter supervision and control of the numbers of public service and commercial vehicles has undoubtedly reduced the output of the manufacturers, it has also reduced the heat of the rivalry between road and rail, and it may be hoped that with the volume of trade increasing each may now find itself capable of making a fair profit.

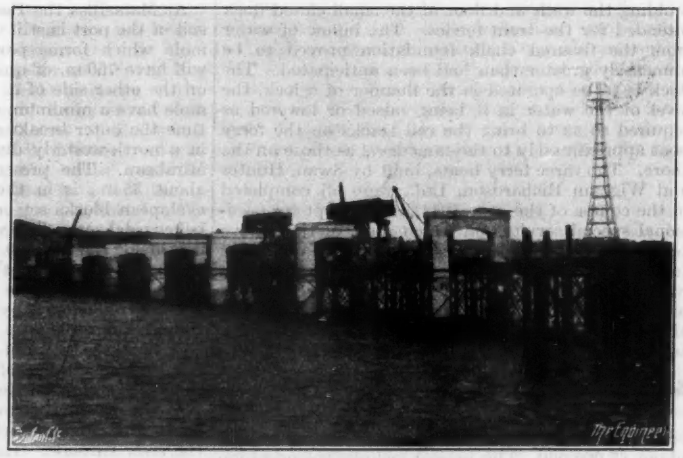
London.

There is nothing of any special note to record as to work done on roads, bridges, or tunnels in the London area. London, by reason of its great size and the congestion of its streets, has special problems to face. But owing to the high value of property within its borders large constructional works need much consideration before they can be undertaken. The year was perhaps more notable for the rapid extension in the use of vehicle-actuated traffic lights and for various experiments in individual streets with pedestrian guard rails and the like than for any major

changes. Work upon road construction was carried out in the neighbourhood of the docks and a plan has been authorised for connecting the Great West Road with Cromwell-road and so bringing an arterial highway far into the boundaries of Westminster. A scheme for building a tunnel under the Thames from Purfleet to Dartford, at a cost of about £3,000,000, is, it is said, viewed favourably by the Minister of Transport and the Traffic Advisory Committee; but, in view of the fact that the London County Council refused to contribute to its cost on the grounds that traffic using it would never enter the London area and that its commitments were already heavy, it may be doubted whether it is likely to come to fruition in the near future. Late in the year a project for a Charing Cross tunnel instead of a bridge was given some prominence in the daily Press. Considerable activity is being shown in the work of bridge building. Chelsea Bridge is in course of reconstruction as a steel suspension structure with a 40ft. roadway, and recently the London County Council, subject to a grant from the Minister of Transport becoming available, condemned Wandsworth Bridge to be rebuilt. For years this bridge has been subject to limits of load and speed. The demolition of Waterloo Bridge was begun in 1934. Early in December the work had reached the stage shown in an engraving in a Supplement to this issue. All the arches are gone and the temporary gantry girders are in course of removal. Work has been begun on the demolition of the piers above the water level. In an illustrated article in our issue of December 20th we described how the work had been carried out. It is perhaps too soon as yet to wonder what will be the effect at the junction of Aldwych and the Strand of traffic to and from the new six-line bridge. Owing to the existence of the Aldwych roundabout eastbound traffic should not be unduly delayed. But what is to happen to the west-bound traffic along the Strand?



KINCARDINE BRIDGE IN AUGUST



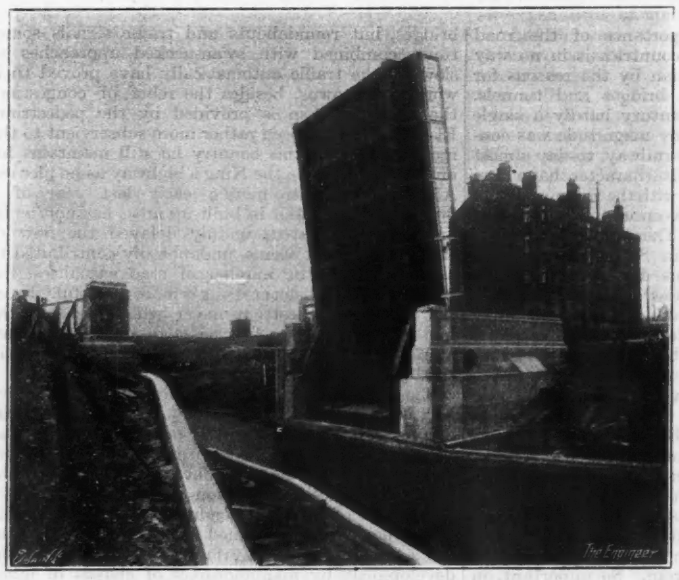
KINCARDINE BRIDGE IN MAY

The British Isles.

Many schemes for bridges and tunnels in the British Isles are progressing along the usual lines of development from mere projects to actual fact, but with the exception of the Kincardine Bridge across the Firth of Forth no bridges or tunnels of any note were either started or finished during the year.

The Kincardine Bridge, for which Sir Alexander Gibb and Partners are the engineers, and the Cleveland Bridge and Engineering Company, Ltd., the contractors, crosses the Firth of Forth just at that point beyond which the width from shore to shore rapidly widens. As will be inferred from engravings on this page, its erection is now in quite an advanced condition. As a result of its completion, traffic from the south to the north-eastern part of Scotland and to the counties of Fife, Clackmannan and Kinross will be much facilitated. In particular, a glance at the map will show that it is situated on the direct line between Glasgow and the mining area of Fifeshire. Although it is not situated far enough down the Forth to make communication between Edinburgh and the Dunfermline district either direct or easy, it will, nevertheless, very much reduce the length of the journey until such time as the proposed Queensferry-road bridge is built. The bridge consists of a central swing span of very large size, giving two 150ft clear openings for shipping. This span is flanked on each side by seven 100ft. spans. Beyond, on the north, there are three 50ft. spans and an embankment, and on the south, nine 50ft. spans and a reinforced concrete approach viaduct. The construction of the foundations was complicated by the fact that there is a fault in the strata approximately at mid river, which necessitated the use of different methods on the north and south sides. In connection with the erection of the bridge an approach road is being constructed on the south and a by-pass road for the town of Kincardine on the north.

Of the many schemes which are being worked out, the most notable are those for bridges over the Forth, the Humber, and the Severn, and for a tunnel under the Tyne. All four schemes have been in existence for a number of years, but the constant increase in the amount of road traffic is making notably more likely in the near future the decision to proceed with their construction. Two sites are in view for the Forth road bridge, but opinion appears to be hardening in favour of that about half a mile west of the railway bridge at Queensferry rather than the alternative at Rosyth. The bridge proposed would have a central suspension span of 3000ft., giving a clearance for shipping of 150ft. One of the two main towers would be built on the Mackintosh rock and the other would be situated on good foundation clear of the entrance to Port Edgar. As a result of a careful examination of the site, the consulting engineers, Messrs. Mott, Hay and Anderson, estimate that the cost would be £3,260,000, as compared with an earlier estimate of £3,650,000. Financial agreements have, we believe, been arranged between the City of Edinburgh and the bodies contributing towards the cost, and the Minister of Transport is likely to be approached with regard to a 75 per cent. grant towards it. It will be remembered that in 1933 a Bill for the construction of a bridge across the Humber was withdrawn from the Commons. The scheme has now been revived. It was divulged during the year that Mr. Ralph Freeman, of Sir Douglas Fox and Partners, had been approached and had put forward a proposal for a bridge with a single great span of 4000ft. If this structure is ever built, it will have the longest span of any bridge in this country. It will even be not far short of that of the Golden Gate bridge at San Francisco. The project for a bridge across the Severn has more recently achieved importance, but by reason of the comparatively lesser cost and the advantages offered by its construction, it has at least as great a chance to be built in the near future as those already mentioned. Two sites are suggested, but that at English Stones appears to be most favoured. Here the shipping channel is only 1500ft. wide, and good foundation rock is available. The bridge would take about four years to build, and, according to the estimates of the engineers, Sir Alexander Gibb and Partners, would cost about £1,554,000.



LAMBHILL BRIDGE, GLASGOW

MACHINERY OF LAMBHILL BRIDGE

Early in this article activity in road construction was mentioned. The Government's five-year plan, under which £100 millions will be spent, is designed to co-ordinate the work of local bodies. Those interested in road transport, however, would be glad to learn on good authority whether this expenditure is to be additional to the ordinary expenditure on the upkeep of the roads, for if it is not, the amount to be set aside is regarded as far too little. Generally speaking, the construction of one road is much like that of another, and deserves no special comment here. But one road reconstruction work of the year occupies an outstanding position on account of the unusual difficulties that had to be overcome. The Chester–Holyhead road, in part of its course along the coast of North Wales, has to pass

around the Penmaenbach and Penyclip headlands, between Conway and Llanfairfechan. Some awkward and dangerous corners at the first-named point were circumvented by the construction of a tunnel carrying a roadway 27ft. wide. Conditions at Penyclip are such that no previous road has successfully withstood the effects of landfalls from above and erosion by the sea below. In an article in our issue of November 1st, 1935, we described how the difficulties were overcome by the construction of a viaduct beneath which the sea can wash against the mountain side. This work, together with the widening of the existing road at other points, was carried out under the direction of Messrs. Howard Humphreys and Sons, and is illustrated by an engraving in the Supplement.

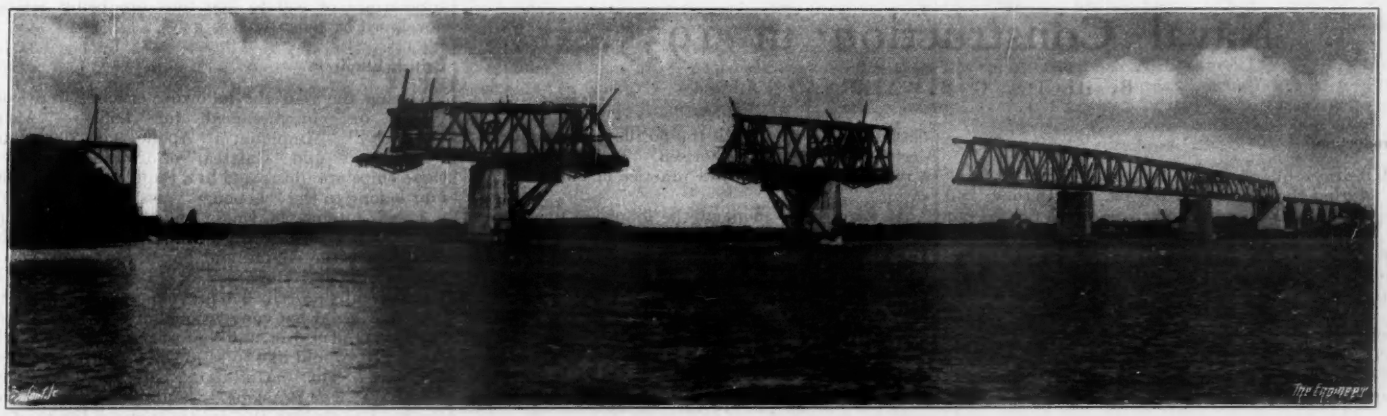
Many of the smaller bridges can be regarded almost as road construction works, and an example of an opening structure is provided by the Lambhill bridge over the canal at Balmore-road, Glasgow, illustrated on these pages. This bridge, the first of its type to be built in Great Britain, was constructed by Sir William Arrol and Co., Ltd., in conjunction with Messrs. Werkspoor, of Amsterdam. Its chief interest lies in the means adopted for opening and closing. The operating gear is shown in one of the engravings, and is housed in the abutment. A constant-speed electric motor operates bull wheels through suitable gearing. There is an arm on each bull wheel having at its outer end a roller which engages with a steel path of trough shape on the tail end of the main girders. As will be followed from the engraving, the steel path is so shaped that there is a gradual acceleration of the speed of opening of the bridge followed by an equally gradual deceleration as the fully opened condition is approached. There is, of course, a similar change of speed when closing. After the bridge has closed the gear continues to revolve and the roller is thereby forced under a lever arm, which compresses a spring. This compression has the effect of applying a downward force at the nose end of the bridge, which is thus firmly held on its seating and locked automatically in the closed position. Nose bolts or locks are not required. The mechanism is so designed that it is impossible to overrun the fully open or closed positions, and it will also be noted that the bridge must necessarily be brought slowly on to its bearings.

Europe.

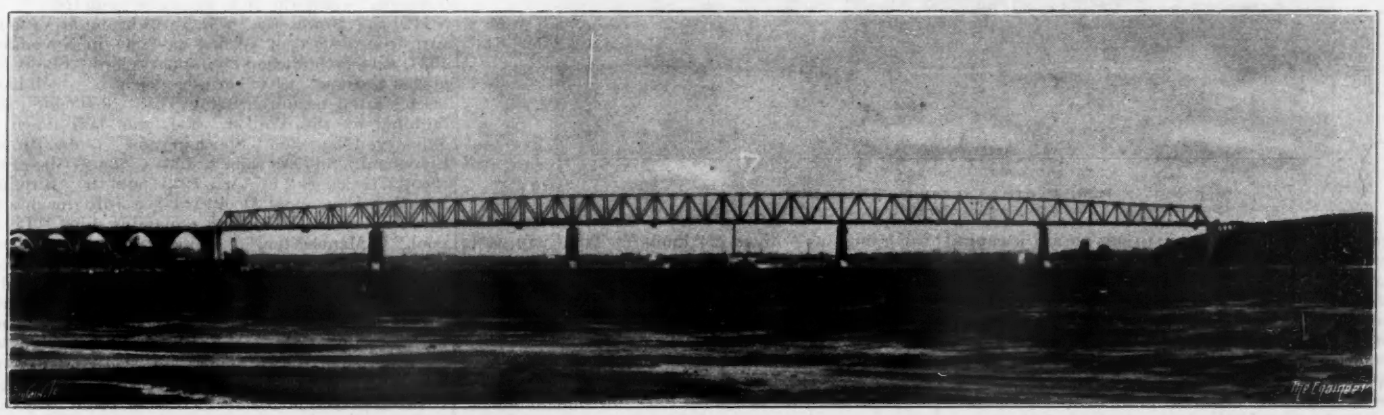
At this time last year we made some mention of the Masnedsund and Storstrom bridges in Denmark. The erection of the first-named structure has been completed, but work on the Storstrom bridge is still in progress. This bridge, it will be recalled, consists of fifty spans, of which three are navigation spans, twenty-four anchor spans, and twenty-three suspended spans. The total tonnage of steel to be erected is 20,000. According to Dorman, Long and Co., Ltd., to whom we are indebted for this information, erection to date consists of two navigation spans, eleven anchor spans, and eight suspended spans.

Another bridge of considerable magnitude completed in Denmark very early in the year is the bridge over the Little Belt, illustrated by two engravings on this page. This bridge connects the island of Fiume, with 327,000 inhabitants, with the main Danish peninsula and carries a road and a railway. Conditions were not suitable for a bridge at the narrowest part of the arm of the sea and at the site chosen the width is 820 m. The structure is remarkable, not so much on account of its dimensions, as by reason of the special means adopted for obtaining secure foundations and for the method by which the superstructure was erected. A group of German and Danish firms collaborated in designing and building the bridge, among which may be mentioned Fried. Krupp A.G., Friedrich Alfred Hütte, of Rheinhausen; and Louis Eilers, of Hanover-Herrenhausen. With its approach viaducts the bridge has a total length of 1178 m., of which the steel spans cover 825 m. There are five steel spans, 137·5 m., 165 m., 220 m., 165 m., and 137·5 m. in length respectively, and the central span gives a clearance for shipping of 33 m. The distance between centres of girders is 16·5 m. and the bridge carries a roadway 5·6 m. wide besides two railway tracks and two footpaths. At the point chosen for the bridge the greatest depth of the sea is 40 m., and although the normal rise and fall of the tide is only 0·5 m., the effect of currents and the constriction of narrow waters causes tides of 3·5 m. at times. Velocities of flow of the currents as high as 3·25 m. per second have been noted. In view of these conditions and of the fact that the sea bottom consisted of good argillaceous material, a method of finding foundations which would minimise the need for the use of compressed air was decided upon. The piers are each carried by a reinforced concrete caisson about 24 m. by 45 m. in plan and 19 m. high. The skirts of the caissons were made as concrete tubes rather more than 1 m. in internal diameter, touching one another and firmly bonded together. These skirts were of different depths according to the depth of the sea at the pier concerned. The caissons were constructed in an inverted position on a special slipway, launched, towed into deep water, turned turtle, and grounded in shallower water, where a reinforced concrete superstructure was built up to a suitable height. They were then again floated by pumping out water ballast and towed to their final positions. Here they were founded on the sea bottom and cranes and other machinery mounted on the superstructure bored into the bed of the sea through the skirt, as shown by the series of diagrammatic drawings. In this way the caissons were sunk to the required depth and the tubes of the skirt and the interior were then concreted up. Despite its continuous appearance, the steel superstructure consists of a series of balanced cantilevers. It was built, as can be seen from one of the engravings, by erecting a temporary structure on the side of each pier. From the broad base thus provided the steel work was cantilevered out on each side.

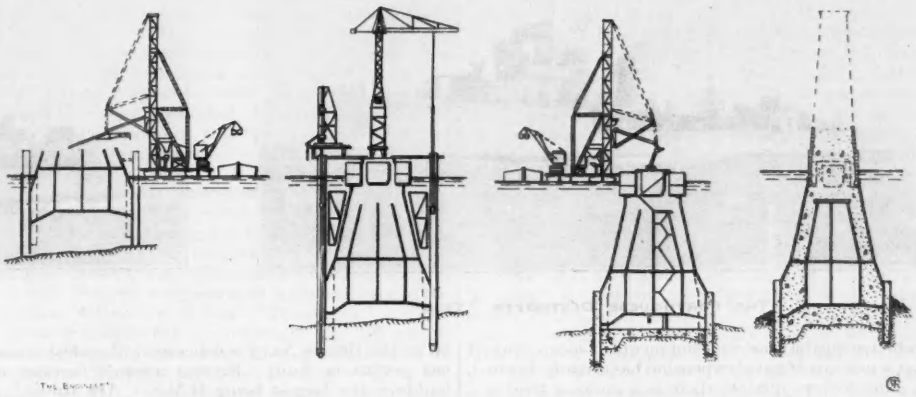
Before leaving Denmark notice must be taken of the projects now being discussed for linking that country



ERECTION OF BRIDGE OVER LITTLE BELT, DENMARK



THE COMPLETED BRIDGE OVER LITTLE BELT, DENMARK



SINKING CAISSONS FOR BRIDGE OVER LITTLE BELT

by a bridge over the Great Belt to Sweden. Danish proposals envisage a bridge from the island of Amager, opposite Copenhagen, to Limhamn, south of Malmö, in Sweden. The total distance is about 20 kiloms., but only 5 kiloms. of bridges would be required, as advantage could be taken of islands and very shallow water. The deepest water encountered would be only 24 m., as compared with 40 m. in the Little Belt. In Sweden a connection between Helsingör and Hälsingborg is being discussed, but on account of deep fissures in the sea bottom which might endanger foundations the project is not viewed so favourably in Denmark.

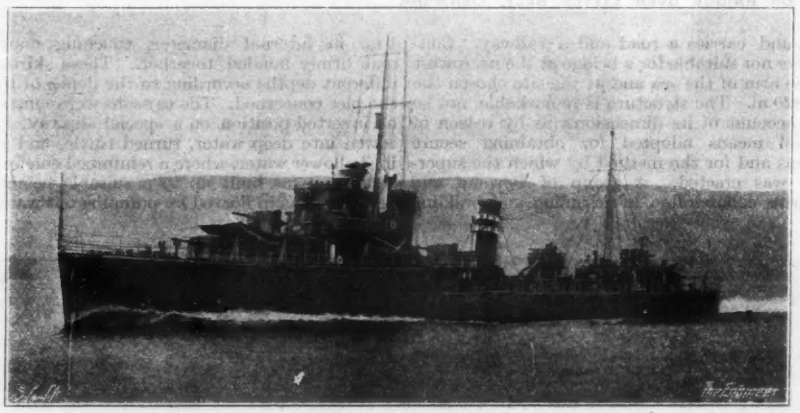
(To be continued.)

Naval Construction in 1935.

By HECTOR C. BYWATER, A.I.N.A.

Introduction.

THREE events of outstanding significance occurred during the year under review. On October 2nd the French battleship "Dunkerque" was floated out of the building dock at Brest, where her keel had been laid in December, 1932. On July 8th details of the current German building programme were officially released in Berlin, and on December 9th the Five-Power Naval Conference opened in London. Each of these events may have far-reaching consequences. The floating of the "Dunkerque" signifies the end of the truce in capital ship construction, and answers in the affirmative a question often posed since 1922, "Is the battleship to survive as the capital unit of sea power?" The publication of the German programme not only heralds that country's reappearance as a naval Power of the first rank, but is of pronounced technical interest. The Naval Conference is still in session, and its outcome is not yet predictable. From the technical point of view, the proposed imposition of narrower limits on the displacement and armament of individual ships is most important. Should those new limits become operative, the sorely tried naval constructor must be prepared to grapple anew with the problem of compressing a quart of fighting power into a pint measure.



H.M. FLOTILLA LEADER "FAULKNOR"

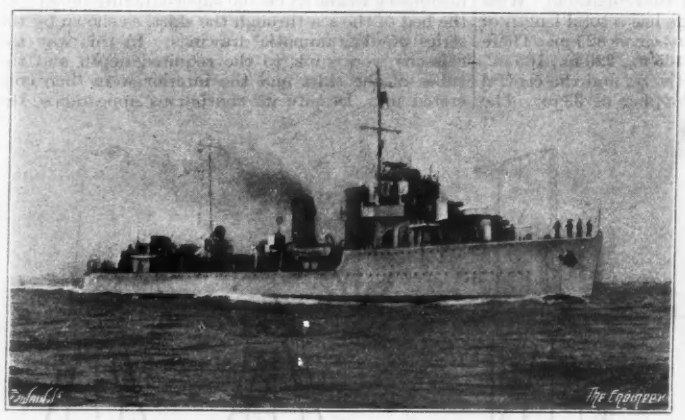
On reviewing the year's developments, it seems evident that a new era of naval expansion has already dawned. In almost every quarter there is a growing tendency to rely more and more on armed strength as a deterrent to aggression. On that subject no comment is offered here, but it is permissible to express gratification at the Government's decision to restore the British Navy to a standard of strength and efficiency more consistent with its immense responsibilities. It is understood that a programme of replacement and renovation covering at least five years is to be submitted to Parliament when the Navy Estimates for 1936 are introduced. Meanwhile, the new construction programme of 1935 has been increased by seven destroyers, additional to the flotilla leader and eight destroyers already authorised. This may portend a reversion to the pre-war practice of flotilla organisation.

At the present moment the following new capital ships are building or authorised:—France, two of 26,500 tons and two of 35,000 tons; Italy, two of 35,000 tons; Germany, two of 26,000 tons. According to such information as is available, all these vessels will have speeds of 29 to 30 knots. It would appear therefore that the long-expected amalgamation of battleship and battle-cruiser has come to pass. On the other hand, a semi-official statement from Washington indicates the speed of the next American battleships as "about 24 knots." They will, it is added, mount twelve 16in. guns and have massive armour protection. Such a design would conform to the traditional American view of what a capital ship ought to be. Cruiser types continue to show much diversity. The smallest ships now under construction are the British "Penelope" and "Aurora," of 5200 tons; the largest are the U.S. "Vincennes" and "Brooklyn," of 10,000 tons, the first mounting nine 8in. and the second fifteen 6in. guns. Intermediate types, ranging from 6800 to 9000 tons, are building in Italy, France, Japan, and Great Britain. Contract speeds vary between 32 and 36½ knots. So far as the British Navy is concerned, the ideal cruiser has yet to be built. Several aircraft carriers are building, the largest being H.M.S. "Ark Royal," of 22,000 tons. Many naval officers deplore the necessity—if necessity it be—of building these abnormally expensive and vulnerable ships. The United States has in hand two carriers of 20,000 tons and one of 14,700 tons; Japan is building two of 10,050 tons. Turning to destroyers, the average displacement of these vessels is considerably higher now than it was a few years ago. In size and gun power, the French "flotilla leaders" surpass all others. In the latest units of this class the displacement is 2884 tons and the armament eight 5·4in. guns. The new British destroyers, of 1350 tons, are slightly smaller than those of the preceding group, but in other countries dimensions continue to increase. Germany, for example, is building a large group of 1625-ton vessels; the U.S. flotilla leaders are of 1850 tons; and Italy has begun four ships of 1449 tons. Very large submarines appear to have fallen into disfavour. In the ocean-going class the universal average has dropped to about 1400 tons, though exceptions are provided by the British "Thames" class, 1850 tons, and the Japanese "I 6–8," of 1900 to 1950 tons. Coastal submarines of 550 to 700 tons are being actively developed by most navies.

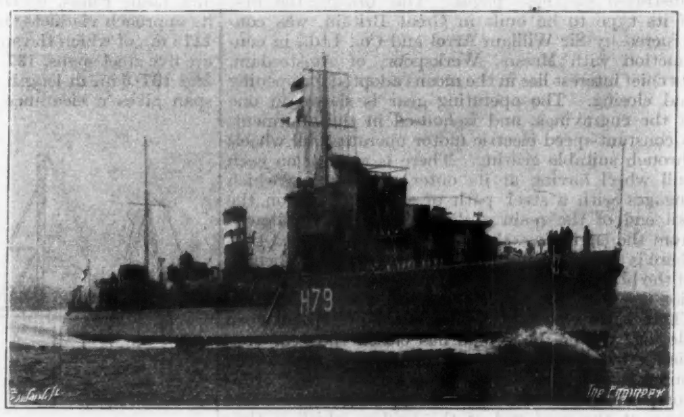
British Empire.

During the year the following cruisers were completed or commissioned for trials:—"Ajax," "Sydney," "Amphion," "Apollo," of 7000 tons; "Arethusa" and "Galatea," of 5200 tons. Three of these ships are illustrated in a Supplement. The first four belong to the "Leander" class, though only the "Ajax" retains the single funnel of the prototype, with boiler rooms grouped amidships. In the other three ships the engine and boiler rooms are spaced alternately, and there are two funnels. This class has been fully described in previous years. Though the design is somewhat conventional, it represents a most useful type of cruiser, and conforms to what the British Admiralty would like to establish as an international standard. The "Arethusa," with her sister ships "Galatea," "Penelope," and "Aurora," were designed to fit into the drastic tonnage limits of the Washington Treaty. The armament of six 6in. guns is weak, but otherwise the type is well adapted to the requirements of convoy and flotilla work. In spite of her small size, the "Arethusa" has a steaming endurance not inferior to that of any other British cruiser. Her machinery lay-out presents several novel features, which are still confidential, though mention has been made in the Press of the "fluid fly-wheel," which enables a switchover from the main engines to the cruising turbines to be made in a matter of seconds. In this ship and the "Galatea," the four 4in. A.A. are for the first time grouped on the after superstructure. In the "Penelope" and "Aurora" eight 4in. A.A. are to be mounted.

H.M.S. "Newcastle," which was begun at Vickers-Armstrongs' yard at Walker-on-Tyne, in November, 1934, is to be launched on January 23rd. She is the first of the new "City"-cruisers, eight of which have been started or authorised. The "Sheffield," also building at the Walker yard, was laid down in January, 1935; the "Southampton" (John Brown, Clydebank), in November, 1934; the "Glasgow" (Scotts, Greenock), in April, 1935; and the "Birmingham" at Devonport Dockyard last July (machinery by John Brown). The three remaining ships, "Liverpool," "Manchester," "Gloucester," were ordered recently from the Fairfield Company, Hawthorn Leslie, and the Devonport yard. The estimated displacement of this class is 9000 tons. The machinery is designed for 75,000 s.h.p., the contract speed being 32 knots. The armament will comprise twelve 6in. guns in triple turrets, eight 4in. A.A., twenty-two smaller guns, and six torpedo tubes. The length between perpendiculars is 558ft., the beam 61ft. 8in., and the mean draught 17ft. Avowedly built in reply to the American "Brooklyn" and the Japanese "Mogami" types, the "Southamptons" seem unduly large for a 6in. armament, and but for Treaty restric-



THE PORTUGUESE DESTROYER "TEJO"



H.M.S. "FIREDRAKE"

tions they would no doubt have carried 8in. or 7·5in. guns. The time is ripe for a new cruiser design, for the Government's replacement programme is expected to contain provision for a considerable number of these ships, and the "Southampton" class is too costly. In naval circles a vessel of approximately 8000 tons, mounting nine 6in. guns, would probably be welcomed.

At the moment of writing, no less than thirty-four flotilla leaders are completing, building, or projected. Of these, the flotilla leader "Grenville," 1460 tons and 36 knots, and the eight destroyers of the "Greyhound" class, 1350 tons and 35½ knots, should be ready for service early

in the present year. The flotilla leader "Hardy" and the eight "Hero" class destroyers are expected to commission before the end of the year. All the destroyers now building have a uniform displacement of 1350 tons, despite the greater size and heavier armament of foreign boats. It is possible that the seven supplementary destroyers of the 1935 programme will show an advance in tonnage and gun power. Including these and two Canadian boats, eighty-eight leaders and destroyers have been provided for since the war. Four new submarines were completed during the year—the "Severn" and "Clyde," 1850 tons and a surface speed of 22¼ knots, and the coastal boats "Salmon" and "Snapper," 670 tons and 13¾ knots. The "Severn" and her sister are the fastest submarines in the world, but their armament of one 4in. gun and six torpedo tubes is not imposing. The coastal boats, which specialise in quick diving, have proved very satisfactory, and their numbers might be increased with advantage. Four separate classes of sloops are now being developed. One is a lineal descendant of the original "Bridgewater" model, built for general purposes, but the displacement has increased to 1060 tons, the speed remaining at 16¼ knots. The complaint that this class hitherto has been undergunned has apparently made an impression, for in place of the two 4in. mounted in earlier ships, the "Aberdeen" is to have three and the "Fleetwood" four 4in. The second type is a convoy sloop, represented by the "Stork" and "Bittern," of 1180 tons and 18 knots; the "Halcyon" type, 875 tons and 16¼ knots, is primarily designed for mine-sweeping; while the "Kingfisher" class, 585 tons and 20 knots, is essentially a revival of the wartime "P" boat, and is intended for anti-submarine duty. Forty-five sloops of the foregoing types have been ordered in the last eight years, and in view of their very limited military power, it may be questioned whether they represent good value for the money. Had the number been halved, the displacement raised to 2000 tons, and the armament proportionately strengthened, we should now possess a most valuable fleet of convoy escorts.

The 1936 Navy Estimates may provide a first instalment for one or more capital ships, to be started at an early date. Alternative designs are understood to have been prepared, but no final decision can be made until the outcome of the Naval Conference is known. The last British capital ships, "Nelson" and "Rodney," were both laid down at the end of December, 1922.

United States.

Steady but rapid progress is being made with the building plan designed to raise the United States Navy to full Treaty strength by 1942. During the past eighteen months, the following vessels have been completed :—

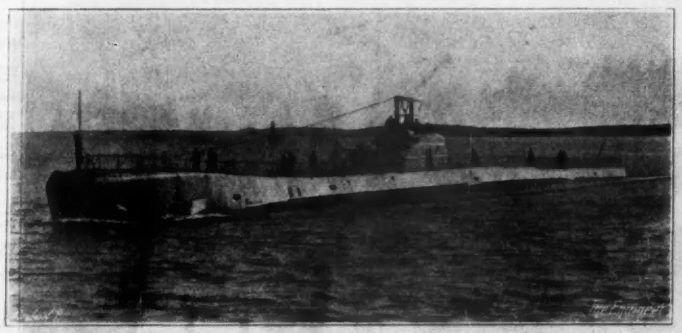
Cruisers: "Astoria" .. "Minneapolis" .. "New Orleans" .. "San Francisco" .. "Tuscaloosa" ..	9,950 tons, 32·7 knots	Nine 8in. guns Eight 5in. A.A.
Aircraft carrier: "Ranger"	14,500 tons, 29½ knots	Eight 5in. A.A. Stowage for 75 aircraft
Destroyers: "Dewey" .. "Farragut" .. "Worden" .. "Aylwin" .. "Hull" .. "MacDonough" "Dale" .. "Monaghan"	1,345–1,410 tons 36½ knots	Five 5in. A.A. Eight torpedo tubes
Submarines: "Cachalot" .. "Cuttlefish"	1,120 tons	One 3in. A.A. 8ix tubes

Work is now proceeding on the following :—

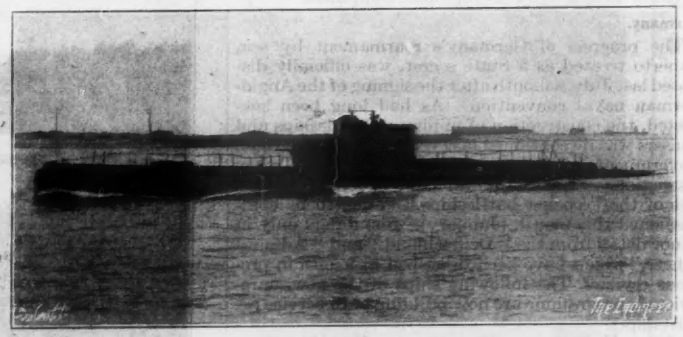
Cruisers: "Quincy" .. "Vincennes" .. "Wichita" .. "Brooklyn" .. "Philadelphia" "Savannah" .. "Nashville" .. "Phœnix" .. "Boise" .. .. "Honolulu" .. "C.L. 49" .. "C.L. 50" ..	10,000 tons 32·7 knots	Nine 8in. guns Eight 5in. A.A.
	10,000 tons	Fifteen 6in. guns
Aircraft carriers: "Yorktown" .. .. .. "Enterprise"	19,900 tons	5in. A.A.
"C.V. 7"	14,700 tons	—
Destroyers:	12 of 1,850 tons	
	41 of 1,500 tons	
Submarines:	16 of 1,290–1,450 tons	
Gunboats:	2 of 2,000 tons (6in. guns)	
	7 of 2,000 tons (6in. guns), for Coastguard	

This immense programme is being financed partly by appropriations under the ordinary Naval Budget and partly by national relief funds.

The new aircraft-carrier "Ranger" was described last year. Shortly after being commissioned she had to be withdrawn owing to defects in her oil tanks, but these have since been remedied. The most striking feature of this ship is her accommodation for aircraft, of which seventy-five can be stowed away. The boiler uptakes are led into six funnels, three on each side of the ship, which are lowered to the horizontal position when flying operations are in progress. The five 8in. gun cruisers completed during the year differ only in detail from their predecessors. It is stated unofficially that a 5in. water line belt is fitted, that armour of the same thickness protects the triple gun turrets, and that a 3in. deck covers all vital spaces. If these figures are correct, the designers have done wonders, for they have also included machinery of 107,000 s.h.p., an armament of nine 8in. and eight 5in. guns, and stowage for four aircraft with two catapults. Several of the new destroyers visited British ports during the year, and the writer had an opportunity of inspecting the U.S.S. "Hull." She is a ship of 1395 tons, 334ft. long by 34¼ft., with a draught of 9¼ft. The machinery develops 42,800 s.h.p., and the contract speed of 36½ knots was made on trial. Five 5in. guns are mounted singly on the centre line behind capacious shields. These guns can be used with equal facility against surface and air targets. There are two sets of quadruple tubes, besides depth-charge throwers and machine guns. Construction is very strong, and the workmanship first-class throughout. The ward room, officers' cabins, and men's quarters are unusually roomy and comfortable. The men berth forward, but they have their own mess in the after part of the ship.



H.M.S. "CLYDE"



PORTUGUESE SUBMARINE "GOLFINHO"

Japan.

The two largest ships completed in 1935 were the cruisers "Mogami" and "Mikuma." Four similar vessels, "Suzuya," "Kumano," "Tone," and "Chikuma," are in varying stages of construction. In this type the Japanese penchant for maximum armament in proportion to displacement would appear to have been carried to extremes. The type is 625ft. long by 59¾ft., draws 15ft., and displaces 8500 tons. The machinery is of 90,000 s.h.p. for a speed of 33 knots. Forward there are three 6·1in. triple turrets and two more aft, giving a broadside of fifteen 6·1in. guns. There are also eight 5in. A.A. guns on twin mountings and twelve 21in. torpedo tubes. A hangar abaft the main mast houses three aircraft, for which two catapults are provided. In view of all this, it is not surprising that side armour is dispensed with, protection being limited to a 2in. deck. As is customary with all recent Japanese designs, there is a great deal of tophamper. Judging by outward appearance, this type should be lively in a seaway. Two aircraft carriers of 10,050 tons, "Soryu" and "Hiryu," and a seaplane carrier, "Chitose," of size unknown, are now building. Two destroyers were completed during the year and twenty more boats are in hand. They are of uniform design—1368 tons, 34 knots, five 5in. guns, and six torpedo tubes. The original number of tubes was eight, but two were removed in consequence of the capsizing of the torpedo-boat "Tomozuru" in 1934, a disaster attributed to overloading. All recent Japanese torpedo craft have their guns mounted in turrets, and in some boats there are steel hoods to the torpedo tubes. Four improved torpedo boats of the "Tomozuru" class are building, 595 tons, 28 knots, three 4·7in. guns, and three tubes. In the original class 4·7in. have been substituted for the three 5in. guns, and weight has been cut in other ways. The only submarine entering service in 1935 was the "I. 69," of 1400 tons, with the high surface speed of 20 knots. Six similar boats are building, besides two submarine cruisers of 1950 tons (17 knots, two 5·5in. guns), and two coastal boats of 700 tons. The average speed of Japanese submarines is higher than that of any foreign underwater flotilla, no less than twenty-four of the boats being capable of 19–20 knots. A cruiser minelayer, "Okinoshima," of 5000 tons, has been laid down.

France.

The 26,500-ton battleship "Dunkerque" was floated out of the building dock at Brest on October 2nd to receive the stem piece, which, owing to the insufficient length of the dock, had to be built separately. Revised details of this ship are :—Length on water line, 686ft.; beam, 101¾ft.; draught, 28ft.; water line belt, 8¾in.; 1¾in. longitudinal bulkhead; 5in. upper deck; 2in. lower deck; total weight of armour, 10,000 tons. Armament: Eight 13in. guns in quadruple turrets forward, sixteen 5·1in. in three quadruple and two twin turrets, forty smaller guns. The "Strasbourg," a sister ship, was laid down at St. Nazaire in November, 1934. Two battleships of a larger type, to displace 35,000 tons, have been authorised, and the keel of the first was laid during December in the Brest dock vacated by the "Dunkerque." Work on the second 35,000-ton ship is to begin on January 1st, 1937, the day after the Washington Treaty expires. An armament of twelve 13in. guns and a speed of 30 knots are unofficially reported. Of the six cruisers of "La Galissonnière" class, authorised in 1931–32, only the nameship has so far been completed. Displacement, 7600 tons; length overall, 587½ft. by 57ft. 4in.; draught, 17ft. 4in. at full load. Machinery, 84,000–88,000 s.h.p., speed 31 to 32½ knots. Armament: Nine 6·1in. guns in two triple turrets forward and one aft; eight 3·5in. A.A.; four torpedo tubes. The clipper bow, raking funnels, and neat superstructure, give these ships a smart and workmanlike appearance. Four others of the class—"Jean de Vienne," "Gloire," Marseillaise," and "Montcalm,"—were launched during 1935, but the sixth ship, "Georges Leygues," appears to be still on the stocks. French constructors are to be congratulated on the performance of the cruiser-minelayer "Emile Bertin," described last year. Displacing only 5886 tons, this ship has the same main armament as "La Galissonnière," and is notably faster. According to a report by her builders (Penhoet, St. Nazaire), her maximum trial speed was 39·8 knots, and, still more commendable, she maintained 37 knots for an hour in a 13ft. swell.

All six ships of "Le Fantasque" class were passed into service during the year. They belong to the class of vessel, which, although designated a flotilla leader in France is a cruiser under the terms of the London Treaty, and of which thirty-two have been built or authorised up to the present. "Le Fantasque" and her sisters displace 2569 tons, the length overall being 434¼ft., and they are driven by Parsons or Rateau turbines. The armament is formidable, consisting of five 5·4in. and four smaller guns, with nine torpedo tubes. The following speeds were logged on trial :—"Le Terrible," 45¼ knots; "L'Audacieux," 43·2 knots; "Le Malin," 43·1 knots; "L'Indomptable," 41·8 knots. These are astonishing figures, though it might be difficult to translate them into terms of tactical utility. Nevertheless, having personally inspected a typical vessel of this group, the writer can vouch for the strength of their construction and the ingenuity lavished on their internal appointments. In a word, they are far from being mere speed machines. Two new flotilla leaders are building, "Mogador" and "Volta," of 2884 tons, with a designed speed of 38 knots, to be armed with eight 5·4in. guns and nine torpedo tubes. Three other vessels were laid down during the year, "Le Hardi" and two unnamed, in which the displacement is reduced to 1772 tons and the guns will be of 5·1in. calibre. This reduction suggests that France is reverting to more normal dimensions in the type of warship under review. She is also building and completing twelve small destroyers—"Escorteurs"—of 608 tons, with a speed of 34½ knots and an armament of two 3·9in. guns and four small torpedo tubes. A number of ocean-going and coastal submarines, all described in previous reviews, were commissioned in 1935. According to the latest official return, France now has eighty-two submarines completed and ten under construction, the total having been reduced in the past year by the superannuation of a number of over-age vessels.

Italy.

Work is proceeding very slowly on the two 35,000-ton battleships which were laid down in October, 1934, the "Littorio," by Ansaldo at Genoa, and the "Vittorio Veneto," by the Cantiere San Marco at Trieste. The following details are official:—Length overall, 774ft. 4in.; beam, 103ft. 8in.; mean draught, 28ft.; designed s.h.p., 150,000, indicative of a speed of not less than 30 knots. During the year Italy completed three more cruisers of the celebrated "Condottieri" type—"Muzio Attendolo" and "Montecuccoli," of 5857 tons and 37 knots, and the "Emanuele Filiberto," of 6791 tons. The generic type has been adequately described in previous notices. The armament in all twelve ships of the group is the same—eight 6in. guns, and three 3·9in. A.A., with four torpedo tubes. The class will be completed by the "Eugenio di Savoia," "G. Garibaldi," and "Luig di Savoia Duca degli Abruzzi," which are still in hand. The increased displacement of the later ships may be due to improved protection and/or increased steaming endurance. Several of the earlier units have reached or exceeded 40 knots, and personal inspection has satisfied the writer that nothing essential to robustness or seaworthiness has been sacrified in pursuit of mere speed. Two small destroyers of 615 tons and 34 knots were delivered in 1935 and four more are completing. They bear a close resemblance to the French "Escorteur" type, described above. Four destroyers of 1449 tons and 38 knots were begun last year.

In submarines Italy, with a total of seventy-seven built and building, is approaching France in numerical strength. Five ocean-going boats, from 860 to 1371 tons, were completed during the year, and in the same period twelve new boats—two oceanic and ten coastal—were laid down. Italian submarines are credited with deep-diving qualities superior to those of foreign boats, and with a simplicity of ruggedness and strength in the vessels and their equipment.

Germany.

The progress of Germany's rearmament by sea, hitherto treated as a State secret, was officially disclosed last July, a month after the signing of the Anglo-German naval convention. As had long been suspected, the construction of miniature battleships and cruisers was discontinued last year, when the German Government decided to ignore the Versailles Treaty restrictions. The "Admiral Graf Spee," third and last of the "pocket battleships," is due to be commissioned this month (January). She differs only in minor detail from the "Deutschland" and "Admiral Scheer," which have been described at length in previous reviews. The following ships of the new, unrestricted, programme are now building or in service:—

Battleships:		
"Ersatz Elsass"	26,000 tons	Nine 11in. guns
"Ersatz Hessen"		Twelve 5·9in.
Cruisers: "G"	10,000 tons	Eight 8in. guns
"H"		Eight 4·1in. A.A.
Destroyers: 16, of 1625 tons		Five 5in. guns
		Eight torpedo tubes
Submarines: 20, of 250 tons		Three torpedo tubes
6, of 500 tons		—
2, of 750 tons		—
Miscellaneous:		
Gunnery training ship, "Brummer," 2410 tons, Diesel engines, speed 20 knots		
Fleet Escorts: "F. 1," to "F. 10," 600 tons, two 4·1in. guns		
Fleet Tenders: "Saar," 2710 tons, 16 knots, three 4·1in.; "Tsingtau," 1970 tons, 17½ knots, two 3·5in. A.A., Diesel electric drive in both		

The new battleships are understood to be vessels of high speed and robust protection. The main armament of nine 11in. guns is comparatively light, but these guns are reported to be of a new quick-loading model. The 10,000-ton cruisers are certain to be well armoured, for ability to resist punishment is still a *sine quâ non* of German design. In view of the well-known prowess of German constructors, further details will be awaited with interest.

Other Navies.

A training cruiser for the Argentine Navy was begun by Vickers-Armstrongs, Ltd., at Barrow, during the autumn. She will be a ship of 7800 tons, with Parsons geared turbines for a speed of 30 knots. The armament is to comprise nine 6in. guns, four 4in. A.A., and six torpedo tubes.

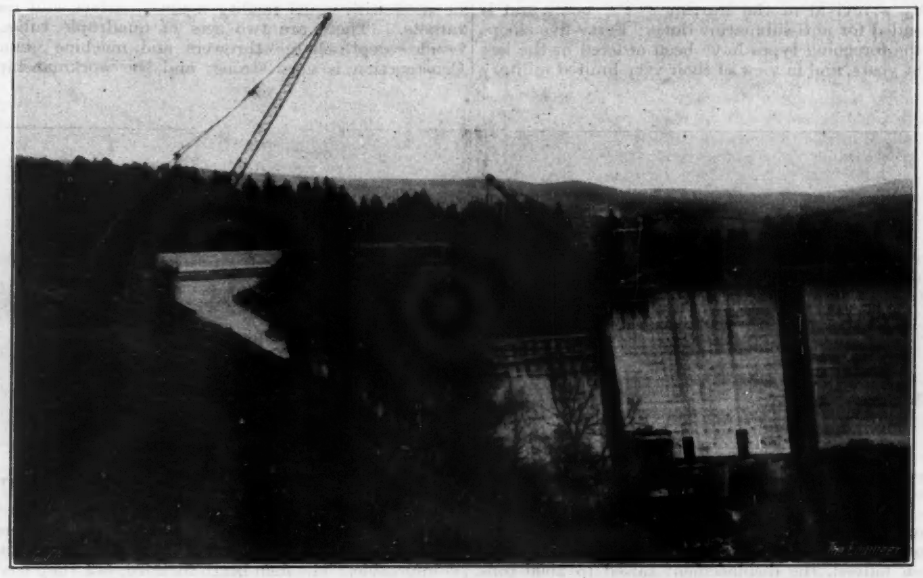
In September the Brazilian Government placed contracts for six submarines of 900 tons with Italian yards.

The Netherlands cruiser "Tromp," officially rated a flotilla leader, was laid down at Amsterdam last year. Displacement, 3350 tons; Parsons turbines of 50,000 s.h.p. for 32½ knots; armament, six 5·9in. guns, six 2-pounder A.A., six torpedo tubes. The cruiser "De Ruyter" was launched at Rotterdam on May 11th, 1935. She will displace 6476 tons, the contract speed being 32 knots, and the main armament seven 5·9in. guns.

Two of the largest torpedo craft ever built in England are now under construction by J. Samuel White and Co., at Cowes, for the Polish Government, and will be launched in the spring of this year. The displacement is 2200 tons, and the overall length 374ft. The contract calls for a speed of 39 knots. Armament, seven 4·7in. guns, six torpedo tubes. There are also illustrated the Portuguese submarine "Golfinho," 854/1105 tons, built by Vickers-Armstrongs, Ltd., and the Portuguese destroyer "Tejo," 1282 tons displacement, built at Lisbon to the designs of Yarrow and Co., Ltd.

Hydro-Electric Power and Irrigation Schemes in 1935.

SO much work is being carried out in the development of hydro-electric power throughout the world that it is quite impossible for us to mention here more than a few representative examples of the works under construction or completed in 1935. In this country there is no work of any magnitude demanding reference other than the second stage works of the Galloway Water Power Company, which are being carried out under the direction of Sir Alexander Gibb and Partners, of Westminster, and which are expected to be completed by the autumn of the present year. The arrangement of the whole scheme, together with more detailed particulars of the first stage works, were described in THE ENGINEER during October, 1934. It will be recalled that the catchment area of 396 square miles lies mainly in Kirkcudbrightshire and is drained by the rivers Dee and Water of Ken. Power is to be developed in five power stations: Tongland, near the mouth of the Dee; Glenlee, Earlstoun, Carsfad, and Kendoon, and main storage capacity is provided by Loch Doon and the Clatteringshaws Reservoir. Glenlee started to generate power early in 1935 and Tongland began to contribute in May. Between them they had generated nearly 80 million units by the end of the year—rather a higher output than had been expected and to be accounted for by the wetness of the late summer and autumn in the area. Preparatory work on the construction of the dams and other works included in the second stage development was begun in the summer of 1934, and the work is now well advanced. Engravings showing the Earlstoun and Deugh dams, both of arch construction, are reproduced herewith and other dams at Loch Doon, Loch Whinnie, Carsfad, and Kendoon have reached a similar stage. The three power station buildings are almost completed and machinery is now being installed. Just before the end of the year the tunnels between the Water of Deugh and the Carsphairn Lane and the Carsphairn Lane and Loch Doon were driven through. In a few months time we hope to complete our description of this power development by giving detailed particulars of the design of all these structures and the methods of building them. It is of interest to note that the great fish ladder at Tongland, about which some little doubt was felt, has proved very successful and has opposed no impediment to salmon ascending the river.



DEUGH DAM OF THE GALLOWAY POWER SCHEME

The Hume Dam.

In Australia a great dam has been built across the River Murray for irrigation purposes. This river forms for a great part of its course the boundary between New South Wales and Victoria, and large areas depend upon its waters for their prosperity. Projects for its development were discussed long before the war, but no work of any magnitude was carried out until the coming into force of the River Murray Waters Act in 1917. By that Act agreement between the States and the Federal Government was reached, and plans for the development adopted. The chief work envisaged consisted of the construction of the Hume dam high up the course of the river near Albury. As first planned, this dam was to create a reservoir with a capacity of 1,100,000 acre-feet, but in accordance with revisions it has now been constructed to impound 1,250,000 acre-feet, and subsequently to have gates surmounting the dam which, when closed, will be capable of raising the level still further to give a capacity of 2,000,000 acre-feet. The central concrete gravity section dam is 1042ft. 6in. long, flanked on one side by an embankment 3913ft. long and on the other by a similar embankment 460ft. 6in. long. The central section includes a length of 720ft. of spillway. The maximum depth of water at the larger capacity will be 126ft. Some conception of the importance of the structure to the prosperity of areas downstream may be gathered from the facts that in 1933 the area irrigated was 170,675, and that at the present time 536,759 acres are being prepared for irrigation and a further project for another 605,000 acres is under discussion.

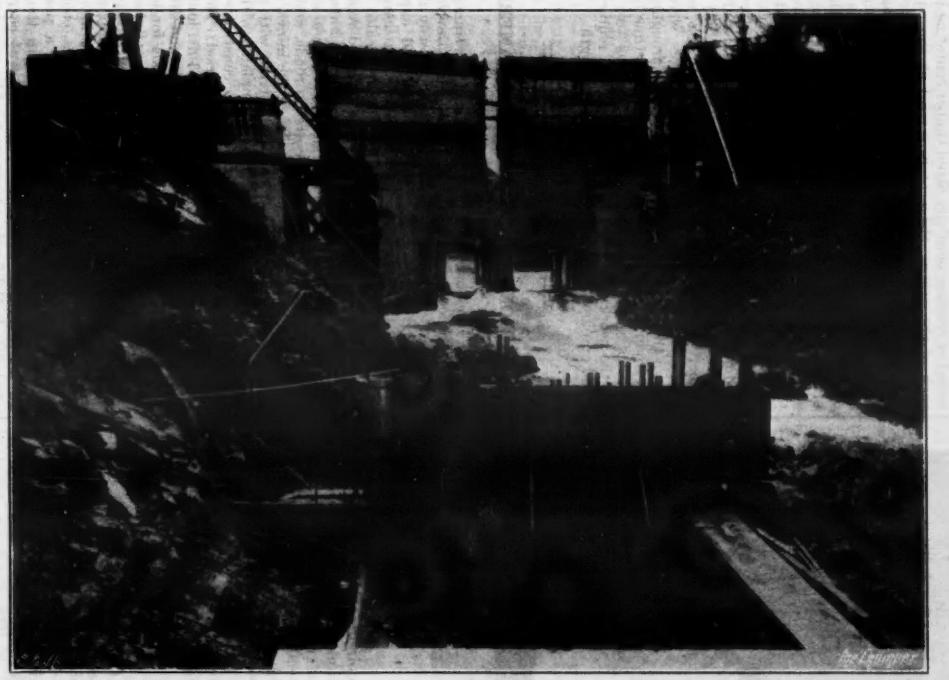
The Colorado River.

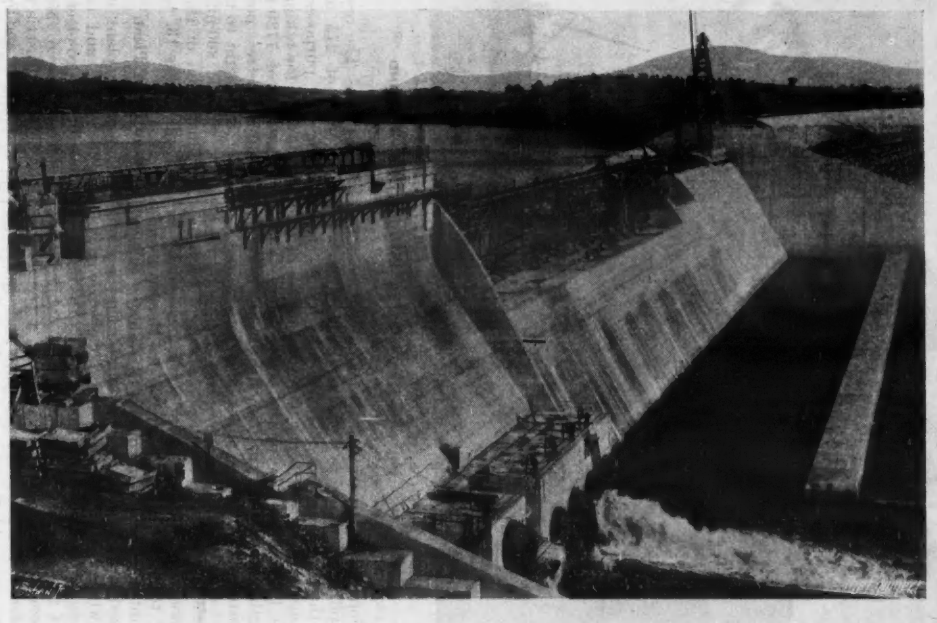
Although the development of the Colorado River, in America, is being carried out with the primary objects of controlling floods and promoting irrigation, power also is to be developed. A number of dams are being built or are projected at various points in the course of the river, the most important of which are the Boulder dam and the Parker dam. For very many years projects for the control of the Colorado River were discussed before effective action was taken. Far down the long course of the river and relatively close to its delta there is situated the Imperial Valley, a depression deep below sea level, which was at one time filled with water, but which has now, except for the Salton sea, dried out. It is a very fertile district, dependent on the Colorado for its irrigation. Until, however, the river was brought under control it existed under the threat of being completely flooded by the bursting of the banks of the Colorado. Twice early in the present century floods in the river burst through and on the first occasion—in 1904—three years' work was necessary before the breach could be repaired. In that time the level of the Salton sea was raised 73ft. In 1909 there was another disastrous flood. In other years great damage has been caused by lack of sufficient water for irrigation.

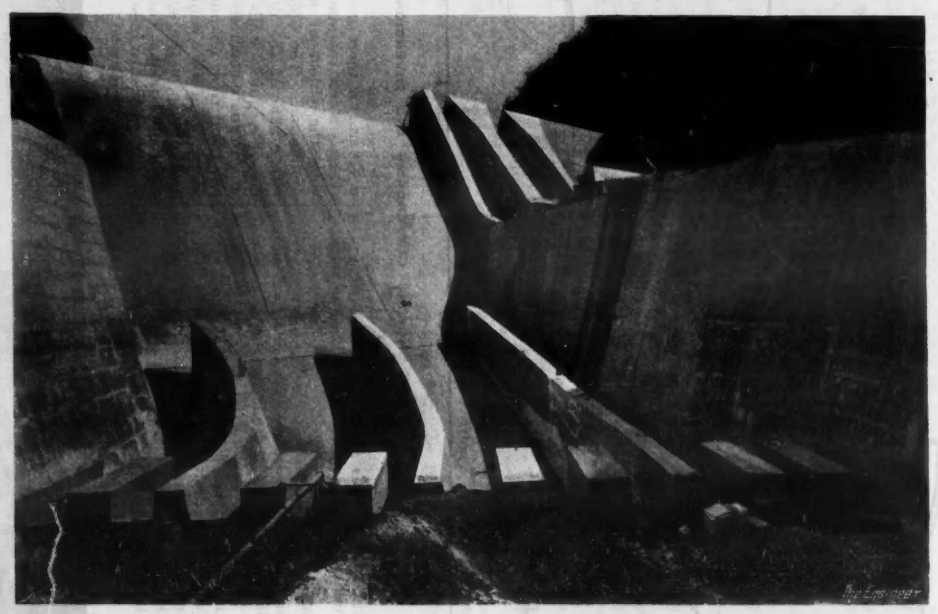
In March, 1931, after several years of discussion as to the siting of the dam, the contract for the Boulder dam was awarded and preliminary work on the construction of diversion tunnels and upper and lower cofferdams was begun. The course of constructional work has been followed by articles appearing in THE ENGINEER at frequent intervals, and no further reference need by made here other than to record that the first concrete for the main dam was laid in June, 1933, while, as shown by the accompanying aerial view, the work is now substantially completed. The dam is of the arch gravity type, with a radius of 500ft. Its base spread is 660ft., its crest width 45ft., its top length about 1180ft., and its height 726ft. It is the highest and greatest dam yet built by man. At present power is to be developed in two 85,000-kVA machines, while another 40,000-kVA machine will be added shortly. Eventually, however, there will be fifteen of the larger and two of the smaller machines developing power.

The Parker dam is situated 150 miles downstream and creates a reservoir from which water will be drawn for use in Southern California for irrigation and other purposes. It will raise the water level to a top level 450ft. above the sea, and the water will be admitted to the great Colorado River aqueduct. It

DAMS FOR WATER POWER AND IRRIGATION IN 1935



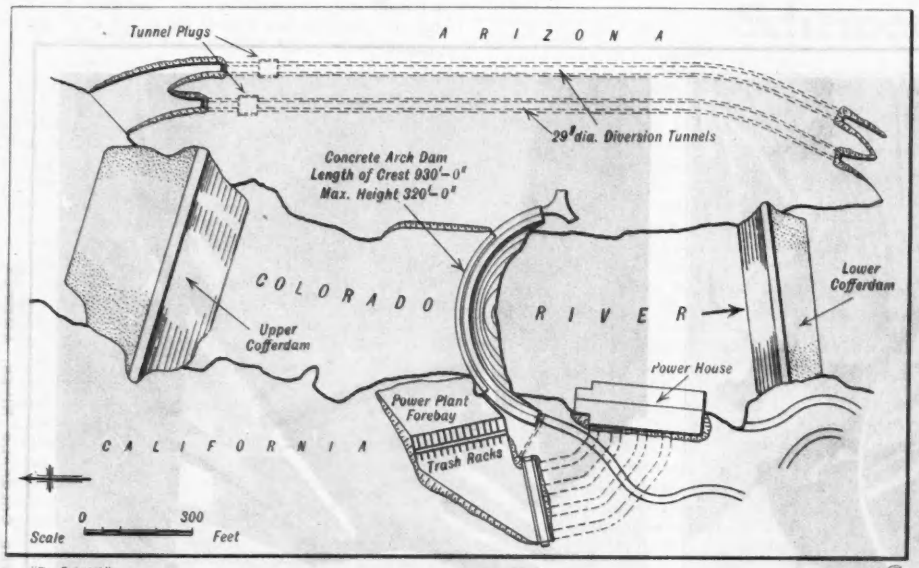




EARLSTOUN DAM OF THE GALLOWAY POWER SCHEME, SCOTLAND
HUME DAM ON THE MURRAY RIVER, AUSTRALIA

BOULDER DAM ON THE COLORADO RIVER, AMERICA
EL KANSERA DAM ON THE OUED BEHT, MOROCCO

will be of the concrete arch type and the top of the dam will contain five gates, 50ft. by 50ft., for the release of flood waters. The accompanying line engraving shows how the dam is to be built on a plan very similar to that adopted for the Boulder dam.



PARKER DAM SHOWING COFFERDAMS AND DIVERSION TUNNELS

The Waitaki Dam.

Although not the largest of its kind in New Zealand, the Waitaki dam, illustrated on this page, is a notable work. Substantially completed before the end of 1934, auxiliary works carried out in 1935 bring it into this survey. The gravity concrete dam is built on a compound circular curve, 2000ft. in radius on the North Otago side and 750ft. in radius on the Canterbury side. It was built in this form not by reason of conditions at the site, but in order to provide sufficient spillway capacity to deal with the high floods to which the river is subject. The spillway has its crest 120ft. above river bed level. The total length of the dam is 1730ft. inclusive of the power house, 350ft. in length. It was built in monoliths, 55ft. in width, with bitumen expansion joints radial to the curve.

WAITAKI DAM, NEW ZEALAND

El Kansera Dam.

A good deal of development work, particularly in regard to irrigation, is going on in Morocco, and, this winter, the reservoir of the El Kansera dam on the Oued Beht was filled. The dam for this development, which includes the generation of electric power, was actually completed in 1934, but, as the summer flow of the river is as low as 1 or 2 cubic metres per second, it was necessary to wait a year before the scheme could be brought into full operation. There are several interesting points about the scheme. While the mean flow of the river is 5 cubic metres per second, it has, for instance, been deemed necessary to give the dam a spillway capacity for 2000 cubic metres per second. The height of the dam is 43 m., and on account of the unexpectedly unsatisfactory nature of the foundation rock, its design and situation had to be modified after the work of building had been begun. Thus it took eight years to build, and instead of lying at right angles to the river is set obliquely across it. The length of gravity dam is 178 m., but more or less in the centre of the structure there is a buttress dam section which was built here with the object of reducing weight upon inferior foundation. The spillway section is delimited on either side of the downstream face by reinforced concrete guide walls which, in conjunction with intermediate concrete guides, redirect the flow along the main river channel. For the protection of the downstream toe a counter dam has been constructed at the base of the spillway section, forming a deep cushioning pool. This counter dam has a serrated crest designed to break up still further the flow of a heavy flood. The reservoir created by the dam has a capacity of 275 million cubic metres. Besides serving the purposes of irrigation a power-house will be used for taking peak loads and is fitted with two groups of 7720-kVA machines, each utilising 20 cubic metres per second when in operation. Water is brought to the power-house through a penstock tunnel, 860 m. long and 4 m. in diameter. An illustration of the spillway section of the dam appears on page 13.

Cardano Power Plant.

The power plant at Cardano is situated in the Isarco valley, and is said to constitute the most powerful hydro-electric development in Europe. The river Isarco finds its source on the Brenner pass between Austria and Italy, and is fed by melting snow in summer and by autumnal rains. Its minimum flow is 25 cubic metres per second, and mean 60 cubic metres per second. In 10 miles between the intake works and the power-house it falls 625ft. Water is collected in a storage basin with a capacity of 63·8 million gallons, and admitted to a tunnel headrace 9·05 miles long. Thence it passes to a storage tunnel with a capacity of 60,000 cubic metres before entering five pipes 2800 mm. diameter, and one pipe 2000 mm. diameter for delivery to the power-house. There are two separate plants in the power-house. The first, generating at 50 cycles per second for industrial purposes, consists of five 45,000 h.p. Francis turbines, and the other generating at $16\frac{2}{3}$ cycles per second for railway traction, consists of three 14,700 h.p. Pelton wheel machines.

SIXTY YEARS AGO.

IN this week's issue we illustrate the progress of the work of demolishing Waterloo Bridge. Exactly sixty years ago—in our issue of January 7th, 1876—we illustrated and described a similar operation on another Thames bridge which, like Waterloo Bridge, had sunk on its foundations and was in danger of collapsing. In 1760 the Corporation of London accepted the designs of Mr. Robert Mylne, architect, for a bridge across the Thames at Blackfriars. Ten years later the bridge, a stone arch structure, was opened for traffic. With London and Westminster bridges then in existence it provided a third river crossing in the metropolitan area. Some years afterwards it was found that its foundations were giving way. Some people believed that the trouble had been caused by the increased scour which resulted from the removal of old London Bridge and its replacement by the less restrictive structure which Rennie had designed. It is certain however that the timber piling on which its piers were erected was from the outset inadequate to support the weight placed on it. In 1833 the bridge was repaired at a cost of over £105,000 or about two-thirds of the sum originally spent on its erection. The repairs effected but a temporary cure. The middle portion of the bridge in the course of years became so dangerous that timber centering had to be placed beneath the arches to prevent their collapse, just as in our own time the same cause led to the same procedure at Waterloo Bridge less than a mile higher up the river. Eventually the Corporation decided to demolish the bridge and erect a new one on substantial foundations in its place. After considerable competition the designs sent in by Mr. Joseph Cubitt for the new bridge—the existing ornate structure largely composed of cast iron—were accepted. In 1864 the contract for the demolition of the old bridge and the erection of the new one was let to Thorn and Co. A temporary wooden bridge was built alongside the old structure to serve the needs of traffic while the work was in progress. The problems involved in demolishing an old bridge—especially one which is on the verge of collapse—without interfering with the traffic beneath it are in their way at least as great as those encountered in the erection of a new bridge. The method adopted by Messrs. Arrol at Waterloo Bridge has recently been illustrated and described in our columns. In the case of old Blackfriars Bridge the contractors appear to have been hampered less than Messrs. Arrol by the necessity to leave the navigable spans unobstructed. The general method of demolition consisted of erecting carefully fitted timber centering beneath each of the arches, the centering used at the navigable spans being in the form of arches which encroached upon but did not completely block up the free passages. A double gantry carrying steam-driven traversers was erected over the bridge. The timber work of this gantry was supported on posts raised on the piers after they had been cut down to the springing of the arches. The gantry served only to facilitate the withdrawal and removal of the arch stones and other material. It did not act in any way to support the arches, as at Waterloo, while they were being demolished. So far as we can gather from our account the arch thrust from adjacent arches after the keystone had been withdrawn was taken entirely by the timber centering. A point of minor interest may be recorded. When the piles for the old piers were withdrawn the timber—fir—was found to be thoroughly sound and when cut smelt like new wood. After a time however it lost its strength and became soft. It was freely used on the works for temporary purposes not requiring the wood employed to have any particular strength.

AVIATION IN MINING WORK IN AMERICA.

IN an increasing number of cases air transport is being utilised to assist mining and mine development in the United States. Its advantages obviously in cases where land transport is difficult, slow, and expensive. One of its limitations is in the relatively light cargo load that is practicable, but this limitation applies also to land transport in difficult country having no good roads. In Alaska, for instance, trails are practically impassable, except when there is sufficient snow to make a safe and firm surface. In summer, there are no roads, and sometimes no streams within many miles of the mines, and an early spring may obliterate the winter trails with melting snow or avalanches. In one case monoplanes with cargo capacity of 800 lb. are used, being so constructed that 9ft. lengths of pipe and timbers can be carried. The cabin partitions are removable, leaving a space 10ft. long, $3\frac{1}{2}$ft. wide, and 5ft. high, with a door 30in. wide and 4ft. high. In winter the planes are equipped with skis for landing, and expert pilots can land them at almost any flat expanse of snow. In summer, they have wheels, but much freight is dropped, the pilots becoming expert in dropping them safely at desired places. In emergency a 20 h.p. Diesel engine was taken apart into four main pieces, each piece wrapped in mattresses and dropped with a parachute attached, the rip cord being operated from the plane. In another case, a 1300 lb. crankshaft was carried by airplane. In California, planes are used by mine managers for travelling and also for shipping gold bullion to the Mint at San Francisco. For topographical and geological surveys of more or less inaccessible country, the airplane with special camera equipment is already widely used, and such survey methods are being developed to very high degrees of accuracy. It is probable that among the many developments in airships and air transport will be important applications to mining engineering.

Rail and Road.

SIR LAWLESS HEPPER, who died at Farnham on Monday evening, December 30th, at the age of sixty-five, after a long illness, had a career of great distinction in the railway service in India, and was afterwards Director of Development, Bombay.

As the Stranraer boat train, which left Euston at 8.30 on the evening of Sunday, December 29th, was running between Parton and New Galloway about 5 a.m. on Monday and after crossing Boat O'Rhone bridge over the river Dee, it was wholly derailed. It consisted of seven vehicles and was drawn by two engines. Two postal attendants received injury.

THE Welwyn Viaduct, L.N.E.R., was built by the Great Northern Railway in 1850, at a cost of £80,000. It consists of forty brick arches, each 30ft. wide. The viaduct has just been extensively overhauled at a cost of £25,000, a task which has absorbed the energies of fourteen expert workmen for five years. During this time they have used 1,181,000 blue bricks, 1100 tons of sand, and 650 tons of cement.

A SURPLUS of £2,547,700 is shown by the report of the South African Railways for the year ended March 31st. This is an increase over the previous year of over £1,023,000. Actually, excess revenue over expenditure, before providing for special appropriations, was £3,327,000. The railways main services revenue exceeded £27,000,000, an increase of £3,314,000, or practically 14 per cent., while the harbours and airways revenue increased by over 20 per cent.

JUST before Parliament rose for the Christmas recess the Minister of Transport stated that the number of crossing places for pedestrians, included in schemes approved to December 14th, were: England and Wales: Outside the London Traffic Area, 11,417; county boroughs, 9174; boroughs, 1261; urban districts, 1154; counties, 239; total, 23,245. Scotland: Large burghs, excluding Glasgow, as an amended scheme has not yet been submitted, 471; small burghs and counties, 112. The total for Great Britain was therefore 23,828.

THE erection of four kiosks, or pavilions, on Hampton Court Bridge, to complete the original design of Sir Edwin Lutyens, has been strongly recommended by the Minister of Transport to the Middlesex and Surrey Joint Committee for Thames Bridges, but the Committee has rejected the recommendation. Upon the report being presented the Chairman of the Council said that a message had been received from the Ministry, asking that the item might be deleted from the Committee's report in order that the Ministry's views might be expressed. He ruled that the item was deleted and refused to allow a member to raise a question.

FAR-REACHING proposals to solve the problem of road congestion in London are put forward in a memorandum issued by the Roads Improvement Association. The memorandum emphasises the great financial loss, estimated at £25,000,000 per annum, arising from traffic delays in the metropolitan area. To overcome this it is proposed to construct a series of circular roads linking the whole of London. Three ring roads are proposed with bridges connecting the service roads. No waiting vehicles, it is suggested, should be allowed on the ring roads, and no access from house doors on to the arteries should be tolerated. It is estimated that these works could be carried out over five years or more, involving an annual expenditure of between £4,000,000 and £5,000,000.

IN a statement received from the L.M.S. mention is made of a recent remarkable ascent of Shap Bank. As the account is accompanied by some very interesting details, we reproduce the particulars in full. The train in question was a Manchester-Glasgow express parcels train. Normally, this train is allowed 43 min. for the 31¼ miles almost continuous ascent from near sea level at Carnforth to Shap Summit Box, 914ft. above sea level. Passing Carnforth 20 min. late, the express, which consisted of ten vehicles weighing 244 tons, hauled by one of the new L.M.S. "Jubilee" class engines, covered the 31¼ miles in 30 min. at an average of 63 m.p.h., thus passing the Summit only 7 min. late. The last 5¼ miles of the ascent, from Tebay to the summit, include 4 miles as steep as 1 in 75, but this section, normally allowed 11 min., was run in 6 min. at an average speed of 55 m.p.h.

IN an address given in Manchester on December 19th, Mr. Everard F. Livesey, of the Southern Railway, said that the traffic between England and the Continent had increased from 150,222 passengers in 1852 to 2,000,000 in 1927. Even in these present difficult times, with the rate of exchange heavily against the English traveller, no fewer than 294,000 passengers crossed between Dover and Calais alone in 1934, while in 1928 the figure was over half a million. The reason why the Southern Company's new train ferry had not chosen the shortest route, *i.e.*, between Dover and Calais, but was using Dunkirk as the Continent port instead, was that at Dunkirk it was able to get an immediate berth for its ferry boats, whereas at Calais or Boulogne it would have had to wait for extensive and costly works to be carried out. The company might, however, some day have a ferry by the short route as well.

A SERIOUS railway disaster occurred in Germany on the evening of Christmas Eve about seven o'clock. A local passenger train from Erfurt to Halle had just left the station of Gross-Heringen, in Thuringia, and was passing over a bridge spanning the river Saale, when it met, in sidelong collision, an express from Berlin to Frankfort. The latter train was being drawn by two engines, and little damage was done to the express and its passengers were practically uninjured. All the eight coaches on the local train were derailed and there was considerable telescoping. Thirty-two passengers in the latter train were killed, but there were no fatalities among the trainmen. Some half a dozen or so passengers are missing, and it is feared that they have fallen in the river. It is officially admitted that the signals were in favour of the departing train, which acknowledgment implies that, as a consequence of the interlocking at the junction, they were against the express.

Miscellanea.

IT is stated in the *Financial Times* that the President of Bolivia has granted a £50,000,000 concession for the harnessing of the waters of Lake Titicaca, situated high up in the Andes, to operate what will be the largest hydro-electric plant in South America. The concessionnaire is said to be Dr. Mauricio Hochschild, the principal of an ore-buying firm on the west coast of South America.

ACCORDING to the Bulletin of the International Tin Research and Development Council, the world output of tin in October last was 15,068 tons, against 10,240 tons in September, 1935. In the year ended October, world output has increased by over 25 per cent. to 129,514 tons. In the twelve months ended October, 1935, world consumption totalled 138,415 tons, this figure being the highest for four years, and 20 per cent. above the previous year's total.

THE Council of the Iron and Steel Institute announces that in accordance with reciprocal arrangements recently completed with the American Institute of Mining and Metallurgical Engineers, members or associates of the I.S.I. who are under the age of thirty-three and who reside in countries other than the United States of America, Canada, and Mexico, will be accepted as eligible for election to the newly established class of Junior Foreign Affiliates of the A.I.M.E. The annual subscription for Junior Foreign Affiliates is 5 dollars, and no initiation fees are payable by them.

IN their concluding remarks in a paper on the production of lubricating oils from coal products before the Institute of Fuel, Messrs. F. C. Hall, W. R. Wiggins, and A. W. Nash said that by the use of modified catalytic materials it is possible to produce from ethylene, lubricating oils with viscosity characteristics comparable with those of certain commercial petroleum lubricants. The condensation of ethylene with aromatics results in the formation of viscous oils which, however, suffer from the disadvantage of poor viscosity-temperature stability. Using a metallic aluminium catalyst, the authors prepared high-grade lubricating oils by the condensation of aromatic hydro-carbons with chlorinated paraffins. The viscosity indices and oxidation stability of these oils were stated to be superior to those of commercial products.

A GENERAL review of the employees' benefit schemes, associated with the Metropolitan-Vickers Electrical Company, Ltd., has disclosed the fact that the present accumulated funds amount to over half a million pounds. This total has been accumulated during the last fourteen years by approximately 13,000 employees, and is made up by works and staff benevolent funds, a male staff pension and life assurance scheme, a female staff benefit scheme, and a thrift scheme which in effect is a savings bank open to all employees domiciled in the British Isles. The various schemes are administered by trustees and committees, whose accounts are subject in general to outside audit, and all the funds are invested either in insurance policies or in trustees securities or their equivalent. Practically all the schemes are supplemented by contributions made by the company.

AT British Industries House, Marble Arch, London, it was stated that a committee had been formed to support the British Empire and China Trade Fair which is to be held at Hong Kong in December, 1936. The committee consists of Lord Derby (patron), Lord Elgin, Lord Sempill, Lord Hirst, Lord Leverhulme, Sir Malcolm Robertson, Sir Francis Goodenough, Sir William Llewellyn, Sir Harry Hague, and Sir Cecil Clementi. The Hong Kong Government has given a site for the Fair and a grant towards expenses, and the project has the support of the Hong Kong Chamber of Commerce and other organisations. In this country the enterprise is being assisted by British Industries House. The object of the Fair is to promote British trade in South China and in the countries of the South Seas. Canada and Australia will send exhibits, and British manufacturers are being invited to take space for the display of their products.

AN article in *Power Plant Engineering* describes a dilatometer made by the General Electric Company of America for the United States Bureau of Standards. This instrument measures and records, in ten-thousandths of an inch, the expansion and contraction of metals as they are heated and cooled. It consists of a small cylindrical furnace surrounding a quartz tube. A round core of about the size of a thick pencil and made of the metal to be tested is placed within the tube, which is then electrically heated to 1800 deg. Fah. On top of the specimen is placed another smaller quartz tube, sealed at both ends, to transmit the dilation of the specimen to a dial gauge. The gauge is connected by an Invar clamp to the outside quartz tube and can be read to 0·0001in. The instrument determines accurately such irregularities as occur when metals expand in irregular jumps, and when they may contract in spite of increased heat.

A MEMORIAL Exhibition is now open at the Science Museum till April 19th, 1936, to commemorate the bicentenary of the birth at Greenock on January 19th, 1736, of James Watt. Among the exhibits are three original beam engines, two of which were erected in Soho Manufactory in 1777 and 1788 respectively, and the third in London in 1797, and various original experimental models, including the separate condensers of 1765 which led to his most important contribution to the development of the steam engine. The Garret Workshop, where Watt frequently worked from 1790 till his death in 1819, and which was moved with its contents from Heathfield Hall, near Birmingham, to the Science Museum in 1924 for permanent preservation, will be on view. A large number of drawings, some by Watt himself, have been lent by the Birmingham Public Libraries Committee, and form a detailed survey of the progress in steam engine design from 1775 to 1800, the period of Watt's partnership with Boulton. Numerous portraits of Watt, Boulton, and their scientific friends have been lent for the occasion, and about one hundred letters between Watt and Boulton are being shown. Special Bicentenary Lectures will be given by the Guide Lecturer in the Lecture Theatre and the Gallery on various days during the period of the Exhibition.

Air and Water.

A NEW type of convoy ship, with a displacement of 600 tons, has been put into service in the German Navy.

IN a series of six trials over a 13-mile course, a Percival "Mew Gull" averaged a speed of over 225 miles an hour.

THE new Japanese aeroplane carrier "Soryu" has been launched. This 10,050-ton vessel will have a speed of 30 knots.

THE Turkish Government has authorised the spending of £3,500,000 over a period of three years on the purchase of aircraft.

FLYING a light aeroplane equipped with a 18 h.p. engine, Mr. Robert Kronfeld recently flew non-stop from Croydon to Rotterdam.

DURING 1935 Clyde yards have launched seventy-four vessels, aggregating 171,930 tons. Aggregates for the whole of Scotland are 104 vessels and 212,050 tons.

THE London, Midland and Scottish Railway has ordered a new motor passenger vessel for service on Loch Awe to replace the steamer at present working there.

A SUM of £20,000 is being contributed by the Egyptian Government towards the clearance of Alexandria Harbour, and an equal amount is being contributed towards the work by the British Admiralty.

WHAT is claimed to be a European speed record for commercial aeroplanes has been set up by a Spanish airman, Señor Ansaldo, who flew a Douglas machine for four hours at an average speed of 217 miles an hour.

ON December 31st, Sir Vincent Baddeley retired from his office as Deputy Secretary of the Admiralty. Sir Vincent has spent over thirty-six years at the Admiralty, and the post from which he has retired will be taken by Mr. J. S. Barnes.

TWO French airmen, Messieurs Genin and Robert, piloting a Caudron-Simoun monoplane with a 180 h.p. Renault engine, have flown from Paris to Antananarivo, Madagascar, in the record time of 57 h. 32 min. at an average speed of 110 miles an hour.

THE Dutch Government intends to continue the reclamation of the Zuyder Zee, and work will be begun shortly on the reclamation of the North-East Polder. The estimated cost of this work is £4,344,000, and it will add about 118,000 acres of land to Holland.

THE United States War Department has decided to build thirteen more of the "flying fortress" type of aeroplanes, at an estimated cost of £50,000 each. These machines are reported to be fitted with four 700 h.p. engines and capable of flying at 248 miles an hour.

THE inaugural flight from Croydon to Lisbon in connection with the new Crilly Airways England-Portugal air service, which was to have taken place on December 28th, was postponed owing to reports of bad weather and water on the aerodromes at Bordeaux and Madrid.

THE new sloop minesweeper "Niger," to be launched at Cowes on January 29th, will be the sixth vessel of the "Halcyon" class, and will be of 875 tons, 2000 h.p., and armed with two 4in. and nine smaller guns. A sister ship, the "Salamander," is also building at Cowes.

THE directors of Air France have announced that its mail service to South America will be carried entirely by air each week in both directions. This new service will take the place of the former part air and part ship service used for crossing the South Atlantic. According to the schedule 104 mail-carrying flights will be made during 1936.

THE new ferry at Renfrew has been put into service. It is much larger than the old one, and will be able to accommodate eighteen medium-sized cars, standing three abreast, as against twelve on the old boat. Raised platforms on either side of the new ferry provide shelter for the passengers, and the new slipways, which are of much greater width, will allow the ferry boat to make a straight run from bank to bank.

ANOTHER order for their special type of economy motor cargo ship has been secured by William Doxford and Sons, Ltd., Pallion, Sunderland—the second within two days. The order is from Morel, Ltd., of Cardiff. Of 9200 tons deadweight, the vessel will be fitted with Doxford opposed-piston oil engines. The Wear shipyards have now twenty-one orders on hand, work upon only a few of which has been started.

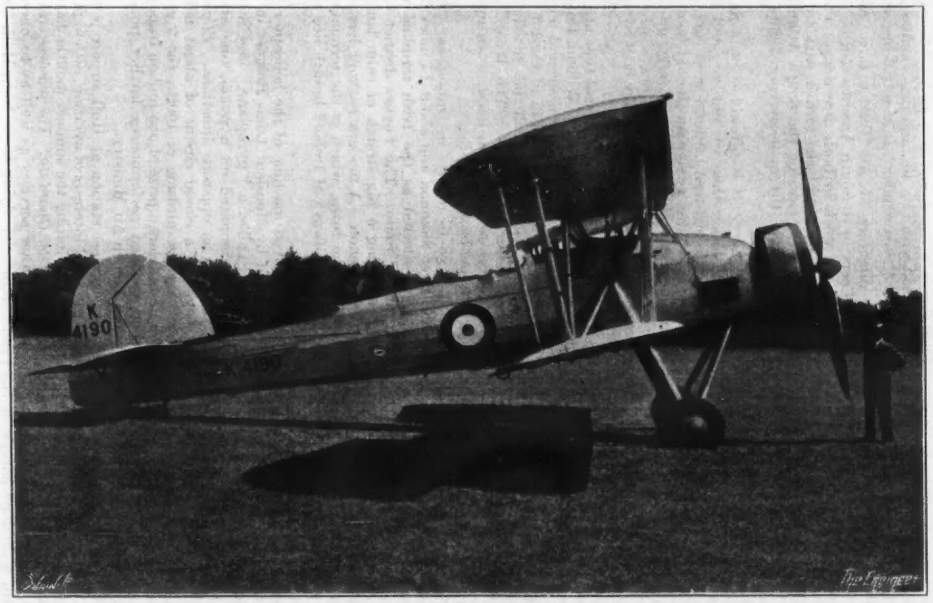
ACCORDING to reports in Dublin, says *Flight*, Foynes, on the river Shannon and about 15 miles from Limerick, has been selected as the Irish terminal of the Trans-atlantic air route. The Foynes district consists of flat land adjoining a big stretch of calm land-locked water on the Shannon. A modern harbour has just been completed at the town, which is the terminus of the Great Southern Railways of Ireland branch line that runs from Limerick.

AN improved machine of the helicopter type has been constructed by Monsieur Louis Bréguet in France. This machine is called a "gyroplane," and its engine drives two rotors mounted on a pylon, one above the other and turning in opposite directions. *Flight* reports that by covering a closed circuit of about half a kilometre at an average altitude of 100ft., the "gyroplane" has won its builders a prize of one million francs. For certain other specified performances further prizes are offered by the French Air Ministry.

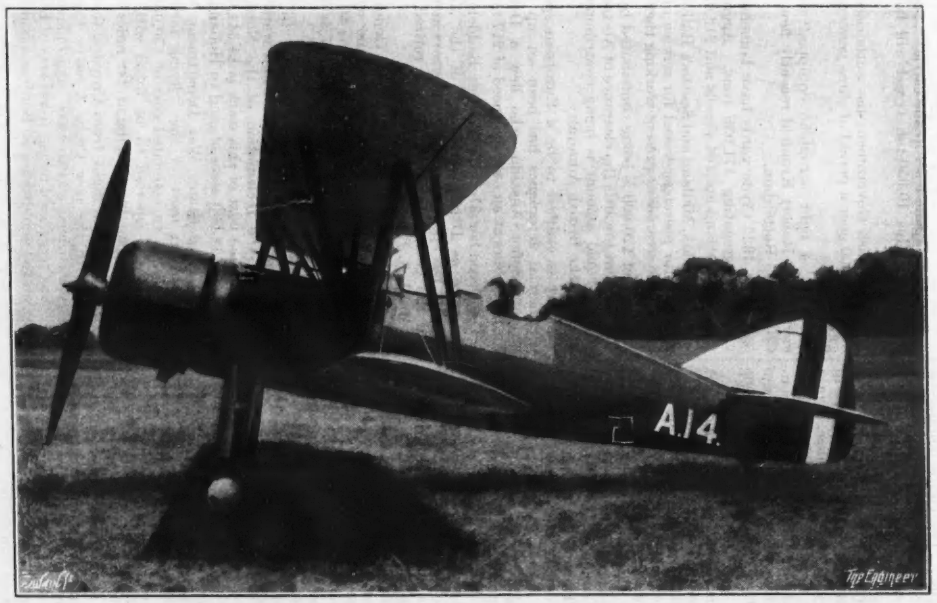
THE wireless station at Hull airport is being retained in the general interests of aviation, although the scheduled services run during the summer months have ceased, says the *Manchester Guardian*. The wireless station is of great value to other services as well as to operators, private and commercial, flying to or from Hull, and Hull is the only airport on the north-east side of England with a wireless station. A widely circulated statement that a passenger air service is to be opened between Hull and Leningrad, *viâ* Gothenburg, Stockholm, and Helsingfors, was declared by the Lord Mayor of Hull to be premature. Although negotiations have been proceeding for some time no definite decision, he states, has yet been reached for the promotion of such a service.

SOME BRITISH AIRCRAFT OF 1935

(For description see page 2.)



FAIREY "SWORDFISH" GENERAL PURPOSE THREE-SEATER



AVRO 636 HIGH-SPEED TRAINER

AVRO "ANSON" MILITARY CABIN MONOPLANE

BOULTON PAUL "OVERSTRAND" DAY AND NIGHT BOMBER

The Engineer

JANUARY 3, 1936.

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Contents.

THE ENGINEER, January 3rd, 1936. PAGE

A SEVEN-DAY JOURNAL ... 1
AERONAUTICS IN 1935. No. I. (Illus.) ... 2
OIL ENGINE TRACTION IN 1935. (Illus.) ... 4
HARBOURS AND WATERWAYS IN 1935. No. I ... 6
ROADS, BRIDGES AND TUNNELS IN 1935. No. I. (Illus.) ... 7
NAVAL CONSTRUCTION IN 1935. (Illus.) ... 10
HYDRO-ELECTRIC POWER AND IRRIGATION SCHEMES IN 1935. (Illus.) ... 12
SIXTY YEARS AGO ... 14
AVIATION IN MINING WORK IN AMERICA ... 14
RAIL AND ROAD—MISCELLANEA—AIR AND WATER ... 15
LEADING ARTICLES—
A Retrospect ... 17
BRITISH MACHINE TOOL MAKERS. No. I. (Illus.) ... 18
SHIPBUILDING AND MARINE ENGINEERING. No. I. (Illus.) ... 21
LOCOMOTIVES OF 1935. (Illus.) ... 24
NEW YEAR HONOURS ... 24
INTERNATIONAL MEETING OF NAVAL ARCHITECTS IN NEW YORK 24
WATER SUPPLY AND SANITARY ENGINEERING IN 1935. No. I. (Illus.) ... 25
ELECTRICAL ENGINEERING IN 1935. No. I. (Illus.) ... 26
MARKETS, NOTES AND NEWS ... 29
CURRENT PRICES FOR METALS AND FUELS ... 30
FRENCH ENGINEERING NOTES ... 31
BRITISH PATENT SPECIFICATIONS. (Illus.) ... 31
FORTHCOMING ENGAGEMENTS ... 32
CALENDARS, DIARIES, &C. ... 32
CONTRACTS AND ORDERS ... 32
LAUNCHES AND TRIAL TRIPS ... 32

TWO-PAGE SUPPLEMENTS—AIRCRAFT, BRITISH WARSHIPS, MOTOR AND STEAMSHIPS, THE WORLD'S TWO LARGEST LINERS, CIVIL ENGINEERING WORKS, ELECTRIC POWER STATIONS, AND BRITISH STEAM LOCOMOTIVES IN 1935.

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A Retrospect.

IN the United Kingdom the great depression is over. As month followed month in the year that is just passed, each showing a little improvement, and as no setbacks ruined hopes as they had done before, and as none is now likely to occur unless the shadow of labour trouble in the mines materialises, we may say with confidence that the slump is behind us. It is difficult to date its coming with accuracy; some place it as far back as 1929, others still earlier, whilst yet others make its existence no more than five years. It all depends upon the industries affected. It is almost as difficult to say when the crisis was safely passed, for there were several temporary recoveries and there are still industries, coalmining, for example, that are still suffering severely, whilst others, like shipbuilding, are not yet out of the convalescent stage.

It is probable that with certain trades we shall have to readjust our scale. Hitherto, 1913 has been taken as a normal year. It was normal for the conditions that then obtained; it is not normal for those that now exist. A new datum to suit the new economic world is needed. It cannot yet be found; there is not sufficient international stability for that. But whilst we are waiting for it, we should avoid the pessimism that is engendered by contrasting the present with a very different past. Engineers have learnt that to estimate the efficiency of engines with an ideal unattainable in practice gives a wrong impression of progress. They therefore compare the efficiency actually reached with that which might be attained under perfect practical conditions.

The same thing must be done in economics. We have to face the fact that our export trade will never again be so great as it was, that we shall never again build so many ships, never again carry such a large proportion of the world tonnage, never again raise so much coal, never again hold the bulk of the textile trade of the world. New competitors have arisen; almost unscaleable tariff walls have been built; every nation of the world is obsessed by the spirit of nationalism; a vast producer is coming slowly, and with much tribulation, into being in Russia. All the industrial nations of the world have shut their doors, more or less tightly, against our products, and we have now closed our doors against theirs. We are forcing ourselves or being forced by others backward upon ourselves. No longer are we the shopkeepers and the manufacturers of the world. Clearly 1935 must not be compared with 1913.

It is not easy, and not very pleasant, to visualise the effect of world changes on this Kingdom. It was an accepted tenet of all economists that it could not flourish without its export trade. Without it we could not pay for the foodstuffs and raw materials which are essential to us. If foreign markets are made more and more difficult to enter, we shall find ourselves in a bad plight. We require easy international trade. The recovery which is now taking place is largely internal; the result probably of tariffs on imported goods. If we can continue to flourish under these conditions, all the economists of the last fifty years have been at fault. It seems unlikely. It is more probable that our salvation, and we may add that of the world, lies in ceaseless attacks on tariff walls and upon the folly of excessive nationalism. Break down the barriers and the revival of industry will not be limited to one or two nations, but will cover the earth. Leave them as they are and the struggle for existence will become greater, until it drives us all into the folly of another war.

Let us pass from these general reflections to particular considerations.

The Steel Trade.

Throughout the year the steel trade aroused excitement in its own ranks and moderate interest in others. The cause was the struggle to come to terms with the Continent. As early as January, the Import Duties Advisory Committee announced that it was prepared to consider applications for the increase of duties on semi-finished steel and on rails, as well as those already promised on bars and girders. The Continent was alarmed, and in March a meeting took place at Cannes. There the British steel makers offered the Cartel a quota of 643,000 tons per annum. That offer was countered by a request for 900,000 tons, which was refused. A few days later—March 20th—a Treasury Order increasing the duties upon nearly all classes of imported steel to a flat rate, which worked out at between 50 and 65 per cent., as compared with the existing 33⅓ per cent., was issued. This drastic use of a tariff had the intended effect. The Cartel accepted the British offer of 643,000 tons per year for a period of three months whilst negotiations proceeded. In the middle of June an agreement for a Continental quota of 670,000 tons for one year, followed by 525,000 tons for four, was signed. It was held that the severe duties had achieved their object, and on August 8th they were lowered to 20 per cent., a figure at which they now stand.

The home trade was also the subject of negotiations practically during the whole year. They culminated in December in the formation of the British Iron and Steel Corporation, which is now the selling organisation of the British industry and controller of Continental imports. On the manufacturing side, the completion of the Corby works of Stewarts and Lloyds, Ltd., fully described recently in our columns, and the decision of Richard Thomas and Co., Ltd., to reopen Ebbw Vale, are the most important items. The announcement of the latter brought much rejoicing to Wales, for it meant the employment of many men who had been out of work since the works were closed down eight years ago.

Unemployment.

The passing of the depression has not yet removed the problem of unemployment. Indeed, it seems probable that the estimate of a constant figure of one million unemployed in the United Kingdom is likely to be justified even in the best of times. Large as it looks, that is not really very unsatisfactory, for it means that the employment machine would be working at something like 93 per cent. efficiency, if we take 15 million as the "working population." (The number of insured persons between 16 and 64 years of age was about 12,780,000 in July, 1935.) Moreover, it means chronic unemployment for a much smaller percentage. The comings and goings, the change from job to job, the geographical movements of industries, the berthing of ships, the state of the weather, and many other causes provoke short spells of unemployment of individuals and groups. Hence, whilst it may be anticipated that there will always be a million unemployed, it will not always be the same million of persons. As far as the welfare of the country and the cost to the taxpayer are concerned that makes no difference, but manifestly it means much to the individual workers themselves.

In this connection the problem of the depressed areas—for which everyone, except the Commissioners, refused the euphemism "special"—occupied much attention towards the end of the year. Humanity says keep these areas alive by Government grants; national economy says let them revert to a condition in which, if they are not useful to the State, they are not a burden upon it. That must happen in the end, for the fundamental laws always win. But we may delay their action; we may soften the hardness with which they bear upon the sufferers and give time for the exodus of the people to take place almost imperceptibly. The danger to be avoided is that of giving a false air of prosperity to districts which are in fact being supported by a tax on others.

The colliery areas are amongst the worst sufferers. The foreign demand for coal, export and bunkers, has dropped by over 40 per cent. since 1913, whilst the improved efficiency of steam plant has reduced their requirements, even though the total output of power is much greater. Oil, too, has had an effect, but it is almost insignificant. Sir Frank Smith showed recently in a lecture to the Junior Institution that, weight for weight, imported fuel oil amounts to less than 1 per cent. of the coal raised in this country. On the other hand, the mechanisation of mines in ten years has increased the output per man-shift from 17·8 cwt. to nearly 23 cwt. The net result is that many miners are out of employment and that many others are working short weeks. That, we think, is the root trouble of the coal strike, timed to start on January 27th, which hangs over the head of industry. The miners want a rise of 2s. a day. It is now generally admitted that they are not earning a fair wage, not so much because the rate of pay is too low as because the number of shifts worked is too small. Owners themselves have expressed sympathy with the miners' complaints, and it seems probable that if the great industries will pay more for their coal means of meeting the miners on the question of the wages themselves will be found. Unfortunately, the men are insistent that wage rates shall be settled nationally and not by districts, and on that rock the negotiations for peace may split. It is unnecessary to say that a coal strike, with one knows not what corollaries, would be a disaster of the greatest national magnitude at the present time, and every effort must be bent on averting it.

If there is one subject more than another on which it is necessary to seek for a more rational basis than that of 1913, it is that of coal output. The fact must be faced that the old conditions will never return and that an inevitable vicious circle must tend to make them worse unless we can find means of reorienting the coal industry. In the course of time the number of men engaged in coal mining will reach a level at which all can be fully employed at a reasonable wage rate; but for the present a high rate must be paid because the hours of labour are short. That means a higher price for coal, a reduction of foreign sales, and the increase in the price of many commodities consumed at home. To meet the latter engineers will be ever more eager in their search for thermal efficiency, so that the demand for the quantity of coal will tend to fall. It has been estimated that an increase of 2s. per ton for coal to a great power station just wipes out the economy in consumption effected in four years of technological progress. A further result of dear coal must almost inevitably be an increased demand for fuel oil. In the endeavour to keep the price down in the face of falling markets the coalowners will be compelled to adopt more and more mechanisation with less and less manual labour. Hence, when all these things are weighed up, we reach the unavoidable conclusion that a serious increase in the price of coal will tend to cause unemployment in the collieries to become more severe.

There are two lines in which rather uncertain escape from this vicious circle may be sought. One is already being explored; it is the hydrogenation of coal into oil. The amount of coal now absorbed in the Billingham plant is only 600,000 tons a year, an inconsiderable fraction of the 220 million tons raised last year; it corresponds to the output of 2000 miners, quite an insignificant percentage addition to the total

of three-quarters of a million or more engaged in coal mining. Manifestly nothing less than an enormous extension of hydrogenation would make any material difference to the unemployment question. The other line of escape is still chimerical. For many years men have dreamt of the conversion of the energy of coal directly into useful power. So remarkable have been the advances of chemistry and physics within the last decade that we may be nearer to that ideal than any existing evidence indicates. It is conceivable that if it could be attained the consumption of coal might be increased by the total displacement of other fuels; on the other hand, the increase of efficiency might reduce demand unless the great cheapening of the cost of power led to enhanced consumption.

Shipbuilding.

Amongst the industries which have had the courage to reduce their capacity to correspond with existing conditions, shipbuilding is pre-eminent. Through the wise activities of National Shipbuilders Securities, Ltd., it has closed in all 159 yards, some of considerable size, and there is now a fair prospect that with the re-animation of trade the yards that remain will before long be better, if not well, employed. But the improvement did not begin till October and, taking 1935 as the whole, only one-third of the new capacity was utilised. In the last quarter of the year a fair number of orders for merchant ships were placed, and the Government will, no doubt, give further orders for naval vessels at an early date. The Shipbuilding Employers Federation estimates that the present year should see half the total number of berths filled in place of the one-third in 1935. We hope to see that estimate well exceeded before our next Annual Review is written. During the year the unemployment figure in the shipyards was, as a percentage, very high indeed; no less than 37·7. But as the total number of insured shipyard workers has been reduced from 358,000 in 1923 to 157,000, the actual number out of work in that trade is less. The shipyards have been very badly hit by the enormously reduced foreign demand for tonnage. True, it improved a little last year, reaching a value of £3,000,000, or double that of the preceding year, but there was a time when we built eleven million pounds' worth of ships for foreign owners, and in 1930 a record figure—on higher price levels—of £20,000,000 was reached. Still the prospects are brighter, and if the scrap and build policy is pursued, as it ought to be, for the latest ships will pay on services where the old will not, it is likely that a good tonnage of merchant vessels will be secured.

Armaments.

From an industrial point of view the Government's decision to increase air, sea, and land armaments is of great importance. One may say, perhaps, that it was precipitated by the Italo-Abyssinian war with its spectre of European complications, but its origin must be sought earlier in the year when Herr Hitler in March defied the clauses of the Versailles Treaty and decreed compulsory military service. It had been guessed or known for a long time that Germany was increasing her military strength, but this overt act left no doubt about it. The Government thereupon began openly to set the Navy in order and to press on with the accumulation of military stores. With the ethical side of this action we are not now concerned. It has, admittedly, done much to destroy what faint hopes there were of world disarmament; but manifestly there was no alternative. The decision had the good effect that it gave employment in armament firms and has given, and will give, increased work in the shipyards. If we regard armaments as a means of preventing war rather than provoking it—a quite tenable view—then we can feel nothing but satisfaction with an action which hastens the flow of money and gives work to the workless. It is fitting that we should mention, as an important event of the year, the opening of the International Naval Conference on December 9th. Its debates are still proceeding, and it would be premature to say anything about them until they are concluded. Amongst our Annual Articles will be found one on the navies of the world from which may be derived, not only a fair view of the relative powers of the nations, but of the nature of the ships and arms upon which each nation places its chief reliance. Our position in the air is also discussed in a special article where mention is made of the increased demand for military machines and of the necessity to attain speeds well over 300 m.p.h., instead of the 250 m.p.h. which may be regarded as the present maximum.

Railway Speeds.

The past year will be remembered as one in which the railways responded to the demands of the public, the competition of the road, and the rivalry of other railway tractors by demonstrating the ability of the steam locomotive to run much faster trains. It is still said not infrequently, that railway speeds are no higher now than they were fifty years ago. In one sense that is true, but it is not the whole truth. For every express train of fifty years ago there are now ten or a score. The remarkable speeds of the 'eighties and 'nineties are now the ordinary speeds. That is one point that should be remembered in making comparisons. An even more important one is that the average weight of express trains has doubled at least, whilst the comfort has been increased out of all knowledge. These things, we submit, must be taken into account in contrasting the speeds of the past with the speeds of the present. If speed, rather than the number of persons carried and the comfort of their accommodation, is the desideratum, then it can be achieved, but at a sacrifice that would satisfy the keeper of records rather than the general travelling public.

The most notable run of the year was unquestionably that achieved by Mr. Gresley's "Silver Link," hauling the new "Silver Jubilee" train on September 27th, when a speed of 112 m.p.h. was reached, with 230 tons behind the tender, and when over 100 m.p.h. was held for 25 miles. This was done on a test run between London and Grantham. The train is a "limited" and has since the test maintained a four-hour service between London and Newcastle, with a stop at Darlington. By earlier tests with existing locomotives, one twelve years old, Mr. Gresley had shown that high average speeds with light trains could be achieved on this route, and the construction of the new locomotives and trains—there are four of them—may be taken as the translation of these experiments into daily service.

Mr. Stanier carried out an interesting test with his "Princess Royal" in June, with a train of increased weight. The Crewe to Willesden (5.25 *ex* Liverpool) is the fastest express on the L.M.S. with the average speed of 64·5 m.p.h. It usually weighs about 360, but on this occasion was brought up to 475 tons. The test showed that the distance of 193·7 miles from Liverpool could be done with minutes in hand in 3 h. 20 min., including stops at Crewe and Willesden, and that between these two stations an average speed of 70·7 m.p.h. could be attained with the heavy train. Very high maximum speeds were not attempted, but for a really heavy train the average was excellent. The actual timing between Crewe and Willesden was 129 min. 33 sec.

Conclusion.

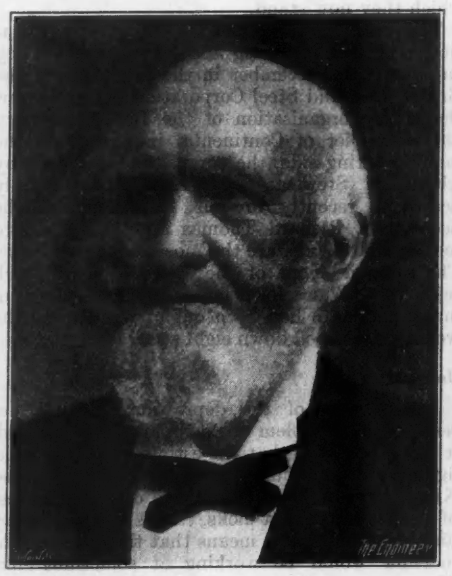
As usual in our first issue of January of each year, we give a series of articles dealing in some detail with the progress during the past year in many of the industries in which engineers are interested. In this Retrospect we have attempted only to present a general view of the position of engineering during the year. As we have indicated, it was a better year than several of its immediate predecessors, and in certain industries it left little or nothing to be desired. The level of unemployment is, however, still high, but there are good grounds for believing that, if we are able to pursue our way in peace at home and abroad, the present year will show month by month an improvement in that respect in nearly all trades. It will, we hope, also bring greater prosperity to professional men, whose fate is too readily overlooked by the public. It is of great importance that men upon whose technical and scientific education a great deal of time and money have been expended should not be forced to look for employment in other fields than engineering. We sincerely trust that for them no less than for insured workers the present year will bring greater prosperity.

British Machine Tool Makers.

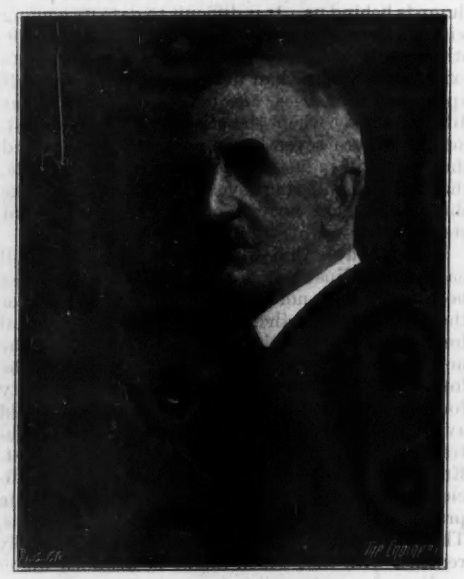
By JOHN HOLLOWAY, M.I. Mech. E.

No. I.

THE particular conditions which prevailed in other parts of the world—notably America—caused the development of machine tools in them to take place more rapidly than in this country, and frequently on lines which it was not economical to follow here. But it must not be forgotten that as England was the birthplace of mechanical engineering, so it was, of necessity, the birthplace of the machine tools used by engineers. There is practically no machine tool that does not comprise in its structure the elements of the engineer's compound slide rest invented by Maudslay; to Nasmyth we owe the milling machine; to Wilkinson the boring machine; and to Roberts the planing machine. In the hands of British engineers these essential machines made great progress. But the conditions of industrial life in this country made it more economical to employ simple rather than complicated, specialised machines. Hence, although examples of early automatics in this country may be found, such machines may be justly regarded as originating principally in America, and, for special industries, on the Continent. As industrial conditions in Great Britain changed, so did the need for new kinds and classes of machine tools arise, and British makers hastened to meet it. It may be said that there is no industry in this country which has advanced with greater steadiness than that of machine tool manufacture. Consequently, we have thought that it would be of interest to follow the rise and achievements of a few well-known firms. This Mr.



EX-PROVOST JOHN LANG, SENIOR



EX-PROVOST WILLIAM B. LANG

John Holloway will do in a series of articles. It is perhaps desirable to say that the order in which the firms will be presented is wholly fortuitous.

JOHN LANG AND SONS, LTD., JOHNSTONE.

The firm of John Lang and Sons, Ltd., was founded in 1874 by the late ex-Provost John Lang, Sen., together with his two eldest sons, John and Robert. Later, two other sons, James and William, joined the firm. All four sons remained in the business, and with their father succeeded in establishing a world-wide reputation for advanced machine tool design of high quality.

It is a notable fact that many of our great engineering firms have had their origin and have been built

FIG. 1—AERIAL VIEW OF MESSRS. LANG'S WORKS AT JOHNSTONE

up by the members of one family. This is true of the firm under review. Its inception was a family interest, and remained so for many years. It is more than probable that its early success was due to the tenacity with which the family held together, coupled with the faith they had in the venture and in their ability to see it through. True, the first few years were difficult, but gradually the name of Lang became known in the machine tool world, and success was assured.

We give portraits of the late ex-Provost John Lang, Sen., and (right) of ex-Provost William B. Lang, the present chairman of the company.

Business was started in a comparatively small building in Johnstone, measuring some 120ft. by 40ft., and about ten men in all were employed making general machine tools.

To-day the works cover about 6 acres, the machine, fitting, and erecting shops alone occupying some 3½ acres, while the number of employees has increased to 1000. What this growth of the firm has meant to the town of Johnstone in employment and wages disbursed can be left to the imagination. The money spent in wages alone since the establishment of the firm runs into millions of pounds, to say nothing of the advantages to allied industries in supplying raw materials for the thousands of machines produced.

An aerial photograph of the present works is shown in Fig. 1. The machine, fitting and erecting shops are seen in the foreground at the left-hand side, while the foundry, pattern shop and pattern stores are seen on the extreme right. A railway siding connects the foundry with the main line, affording facilities for receiving raw materials.

A view of the interior of the machine shop is given in Fig. 2, this being a bay in the surfacing and boring department. Fig. 3 shows a bay in the testing and inspection department.

At the time John Lang and Sons started business, the machine tool industry was well established. Many improvements had been made on the early machines originated in London by Maudslay and Roberts, among others, and screw threads had been standardised by Whitworth. But much development work remained to be done. Machines were still being made with cast gears, and the chatter caused by inaccurate teeth was often found to be transferred to the work piece being machined. Furthermore, the range of speeds and feeds provided was very limited, and it was generally necessary to stop the machine to change either the speed or feed. Moreover, the cutting speeds were low and the degree of accuracy attained left much to be desired.

Meanwhile, engineering science was making rapid progress. The railways were extending, and the steam engine was finding an ever-increasing market. Consequently, bigger and better machine tools were looked for, while precision of machining to at least a moderate limit of error began to be demanded. Here, then, was the opportunity for the machine tool maker of vision and ability. Langs were not slow to take it.

American machine tool makers were already busy. They had been quick to realise the possibilities of the machine tool, and taking all the advantage they could of the experience and work of British pioneers, they were soon making improvements leading to greater productivity and precision, as well as evolving new types of machines. News travelled pretty quickly even in those days, and in 1880, only six years after starting in business, Langs heard of a new automatic gear-cutting machine being made in America, and John Lang, Junior, the designer to the firm, went over to investigate. His report was so satisfactory that the firm promptly bought one of the new machines from Gould and Eberhardt, U.S.A., installed it in its own workshops, and began cutting gears and fitting them to all the machines they made.

This machine proved to be the first automatic gear-cutting machine installed in Europe, and so great was the interest it created, that people from all parts of Europe came to see it in operation. Thus Langs became the first firm on this side of the Atlantic to fit machine-cut gears to machine tools. As may naturally be supposed, this enterprise gave a tremendous advantage to the firm, and made it known to many people all over the world.

But that was not the only effect the visit of John Lang to America had on the destiny of the firm, for while over there he visited many works, and noticed that almost without exception every plant was concentrated on producing one type of machine only.

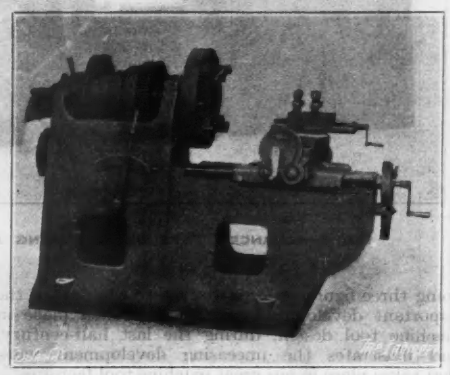


FIG. 4—SURFACING AND BORING LATHE

The advantages of this were too obvious to be overlooked, and on his return home, the firm decided to concentrate all its resources on the production of lathes. Henceforward the slogan of the firm became "Langs for Lathes."

The decision to specialise in lathes soon proved to be a wise one. New models, having distinctive and novel features, followed very quickly. At the same time, general design and improvement in detail to facilitate operation received attention.

One of the important developments, following close on the introduction of machine-cut gears, was the short bed, surfacing and boring lathe, made without the usual loose headstock. The first of these machines was built during the year 1881. An early type is shown in Fig. 4. As will be seen, it was designed for chucking work exclusively, hence a loose headstock or tailstock, as they are called in many districts, would be superfluous. Prior to the advent of this machine, however, chucking work had always been done on the ordinary centre lathe, known familiarly as the S.S. and S. lathe, made with the standard length of bed, with the result that the greater part of the lathe bed and the tailstock remained unused while chucking operations were carried out, in addition to which a much greater floor space was occupied than was necessary.

To such practical men as the Langs, this practice appeared wasteful, as, indeed, it was, but it does not require much imagination to realise the courage and initiative needed by a young firm to break away from orthodox design and evolve a new type. But the results justified the decision taken, and the

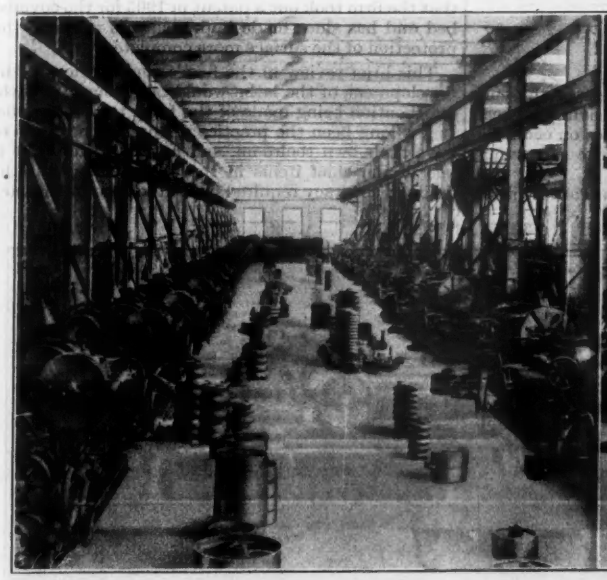


FIG. 2—MACHINE SHOP

FIG. 3—TESTING AND INSPECTION DEPARTMENT

chucking lathe soon became a recognised standard machine. Improvements in the design continued to keep pace with the more modern requirements, and by 1905 the lathe had taken the form shown in Fig. 5.

The present-day lathe developed from the original type is shown in Fig. 6. A comparison of the foregoing three figures affords a striking example of the important developments that have taken place in machine tool design, during the last half-century, and illustrates the unceasing development work that takes place in our great machine tool factories.

But the features in the original Lang surfacing and boring machine were probably more important than was at first realised, and though at this date it may be difficult to say precisely how far or to what extent it influenced designs that followed, it can be said that so far as can be ascertained Langs were the first to design and construct a lathe for the express purpose of carrying out the operations of surfacing and boring, and that it was the first engineers' lathe designed to dispense entirely with the loose headstock. It may therefore be claimed that the original "Lang" was the prototype of the capstan and turret lathes that followed. Here, then, is a real and substantial contribution to the art of machine tool design; a machine made for a purpose, and with a definite end in view, but which, in the process of evolution, becomes of almost universal application in the machine tool industry.

In a relatively short article, as this necessarily must be, it is only possible to deal with a firm's major achievements. The mass of improvement in details can only briefly be dealt with. But particular mention must be made of another of the firm's inventions, widely known as "Lang's variable speed drive." Many machines have been fitted with this type of drive. A whole battery of surfacing and boring machines with the variable speed drive is seen in Fig. 2, this being from a photograph of one of the bays in the firm's machine shop. The specially constructed belt with the bevelled edge driving between the V pulleys, formed by a pair of cones on each side of the headstock, can be seen in the engraving, particularly on the left-hand side.

A patent for the variable speed drive was taken out in 1900. It is acknowledged by many machine tool makers that it was the origin of the modern all-geared headstock, so much in evidence to-day on many types of machines. The drive has been fitted to other types of lathes, and in the machines of the 1920 period the bevelled edged belt is practically completely covered, much in the same way as the all-geared head. With the Lang variable speed drive a constant cutting speed can be maintained when facing large wheels or discs, the revolutions of the work piece increasing automatically as the tool travels from the periphery to the hub.

Meanwhile the development of the S.S. and S. lathe has kept pace with that of other types, as comparison will show. Fig. 7 illustrates a Lang lathe of the 1890 period and Fig. 8 that of 1934. Both machines have points that show the trend of advancement in the period when they were made. The 1890 model, though a plain-looking tool, is not to be despised for that. It was a champion of its time. The gear wheels are machine cut and the presence of the lever at the front of the headstock indicates feed change gears on the feed shaft at the back of the lathe bed. This is the forerunner of the modern feed change gear-box, for at that time most lathes were still being made with the feed shaft driven by belt and step cone pulleys. Fig. 8 represents the modern conception of the fully developed centre lathe.

The machines shown in Fig. 6 and Fig. 8 may be taken as representing Lang's standard high-production lathes, and though of different types, they have much in common as regards materials, workmanship, and manipulation. They have texrope motor drive and all-gear headstock having twelve speeds. All gears are nickel-chrome heat-treated steel with ground teeth and spindles of high-carbon steel, accurately ground. The front bearings have Lang's patented pre-loaded type roller bearing, which takes radial load and end thrust; the back bearings have plain roller bearings. Twenty-eight feeds are obtained by simple movement of levers.

All Lang lathe beds are made with the narrow guide to the saddle, a practice initiated by the firm in 1899, which has now been adopted by most machine tool makers. Covers are also fitted to each end of the saddle to protect the guiding surfaces of the bed from chips and grit. It is interesting to note that the firm took out a patent in 1905 for the covered bed and has since made improvements to make the protection of the surface more complete.

This brief review of the firm's contribution to the development of the lathe would be incomplete without mention being made of the Lang toolroom lathe. It has long been the practice of engineering firms to have their own toolroom, and naturally the lathe is one of the chief items in the equipment. But the limits of accuracy required in the toolroom plant vary according to the nature of each firm's product, and taking a practical view, Lang's supply a toolroom lathe with all the necessary equipment to meet general requirements, and with finer limits of error than are usual with ordinary production machines, but which still remains a commercial proposition.

A general view of the toolroom lathe is given in Fig. 9, while the methods of testing and the limits

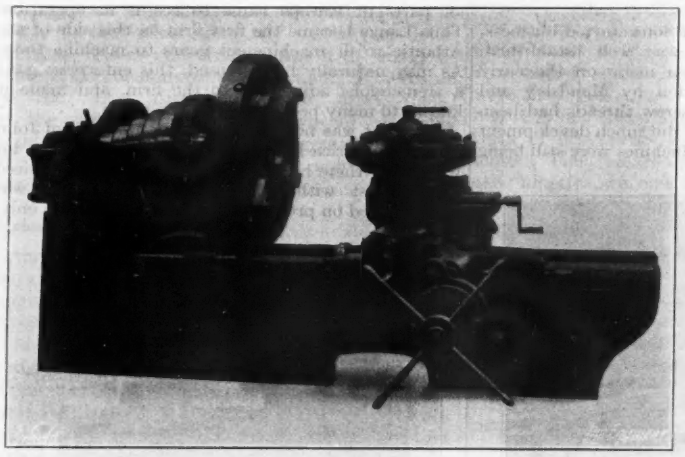


FIG. 5—ADVANCED TYPE OF SURFACING AND BORING LATHE

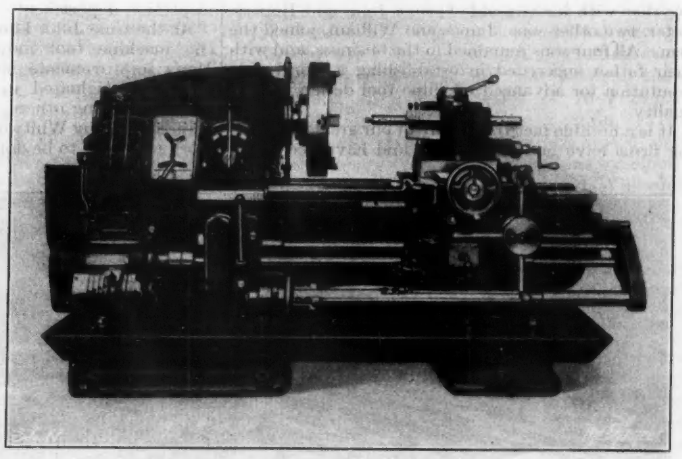


FIG. 6—PRESENT DESIGN OF SURFACING AND BORING LATHE

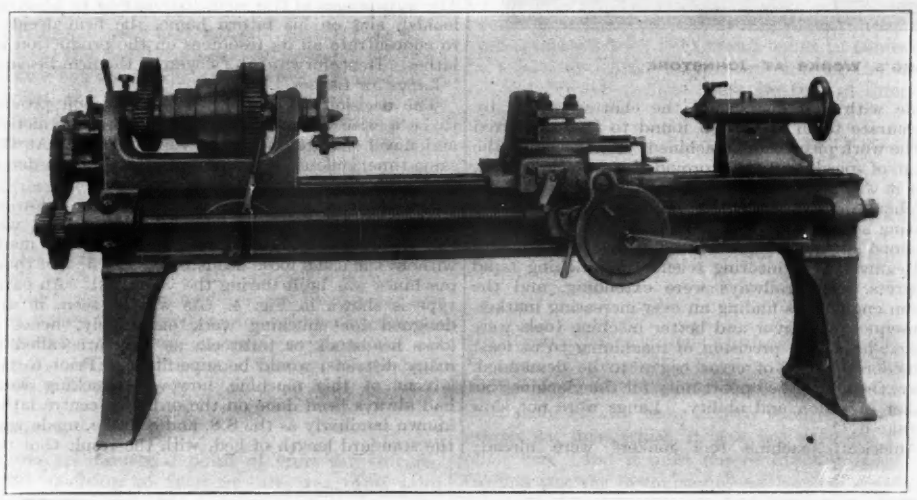


FIG. 7—CENTRE LATHE OF 1890 PERIOD

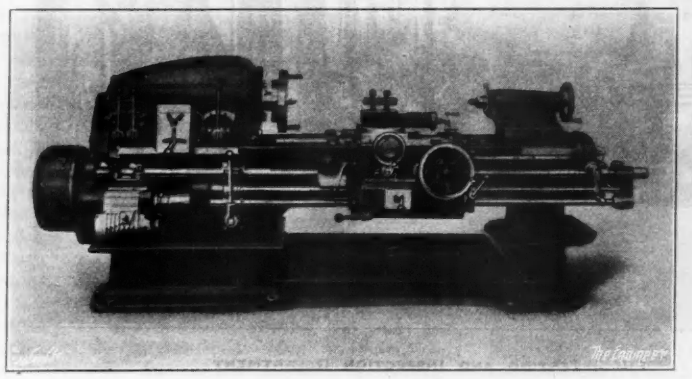


FIG. 8—LATEST TYPE OF S.S. AND S. LATHE

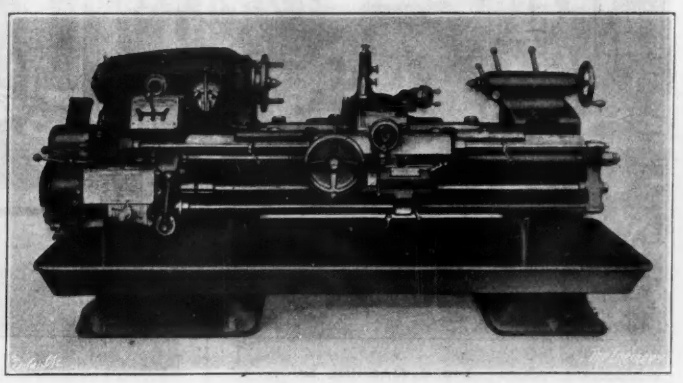
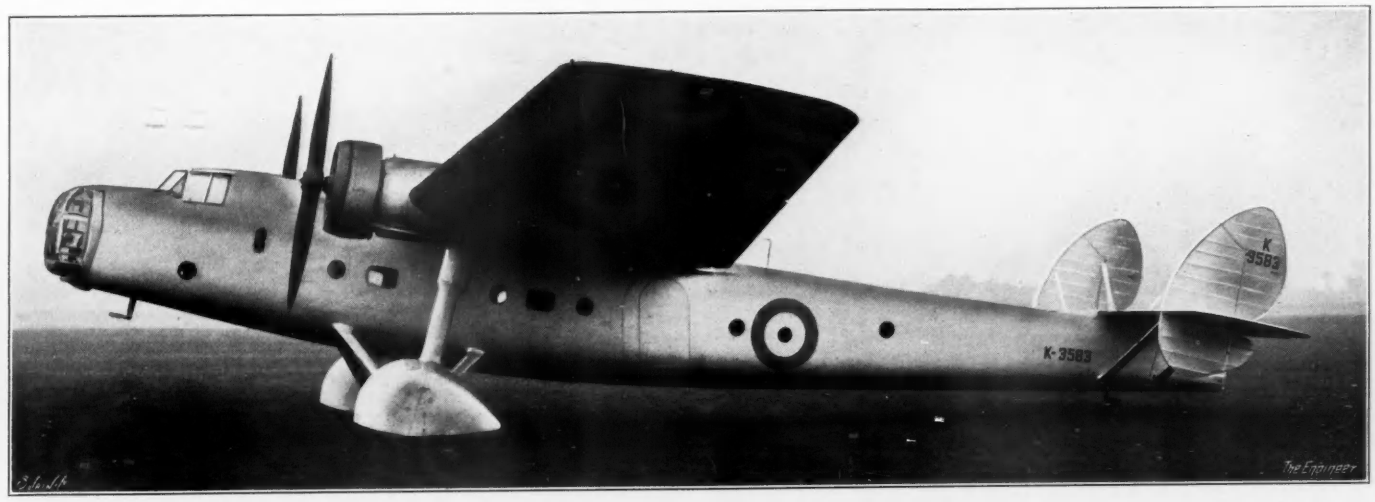
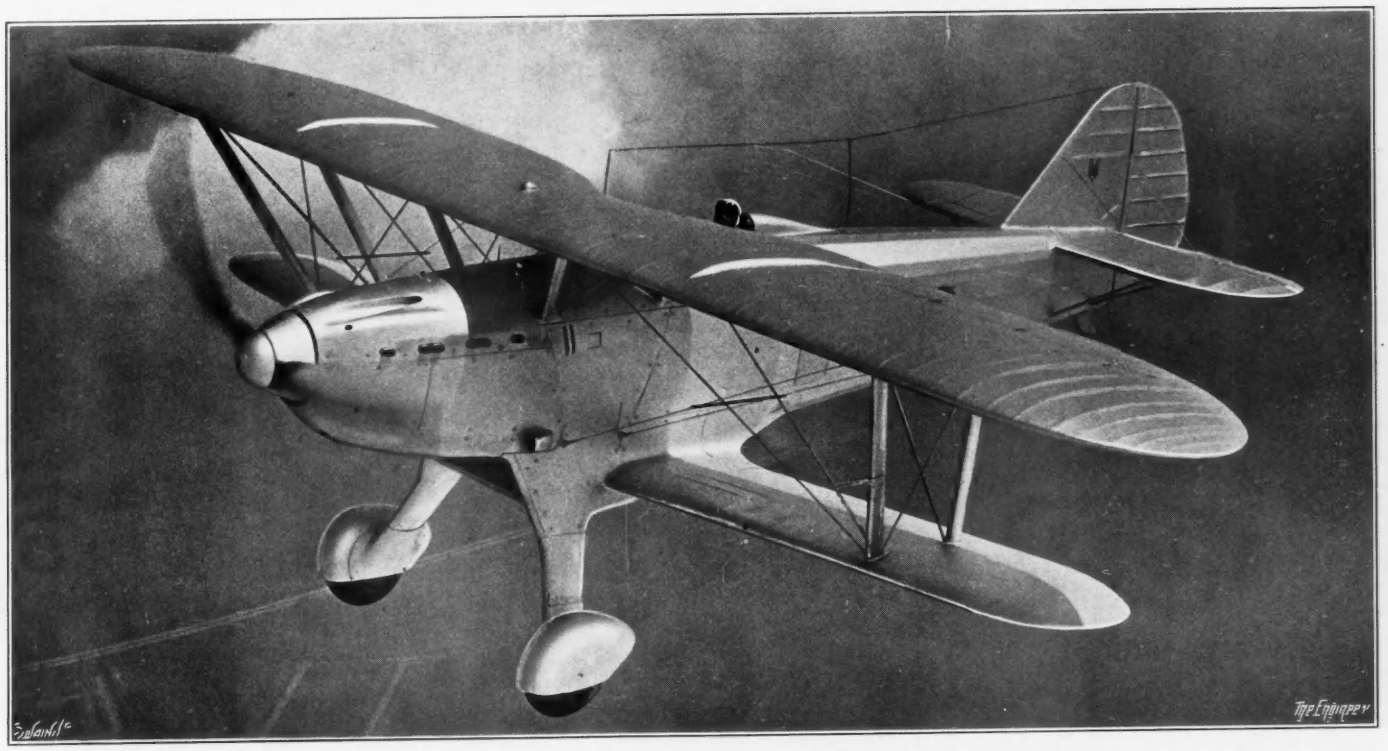


FIG. 9—PRECISION TOOLROOM LATHE

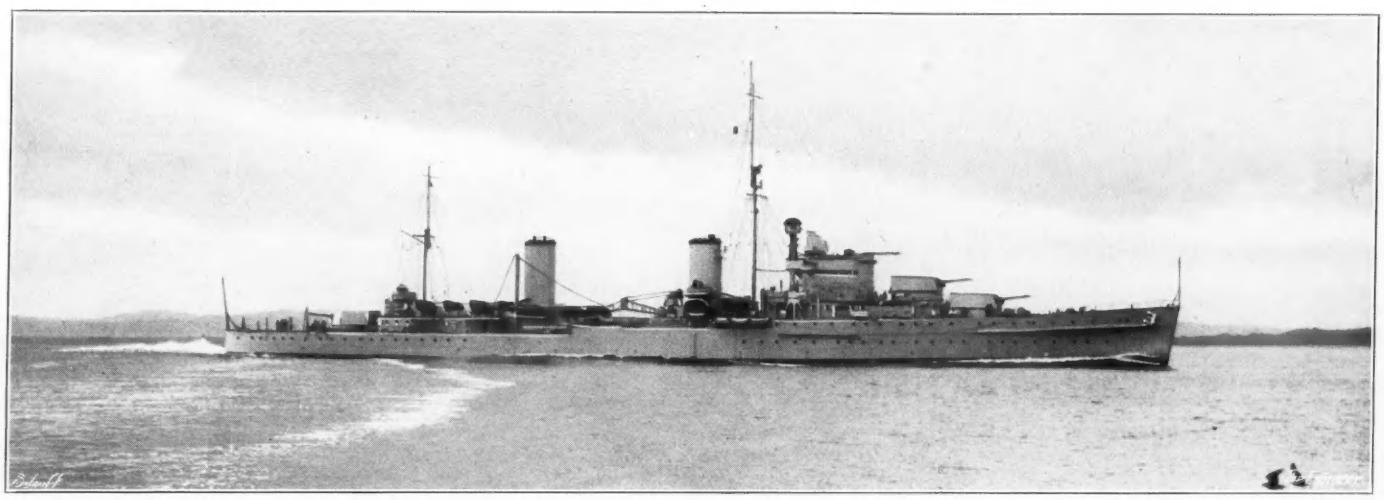
AIRCRAFT OF 1935

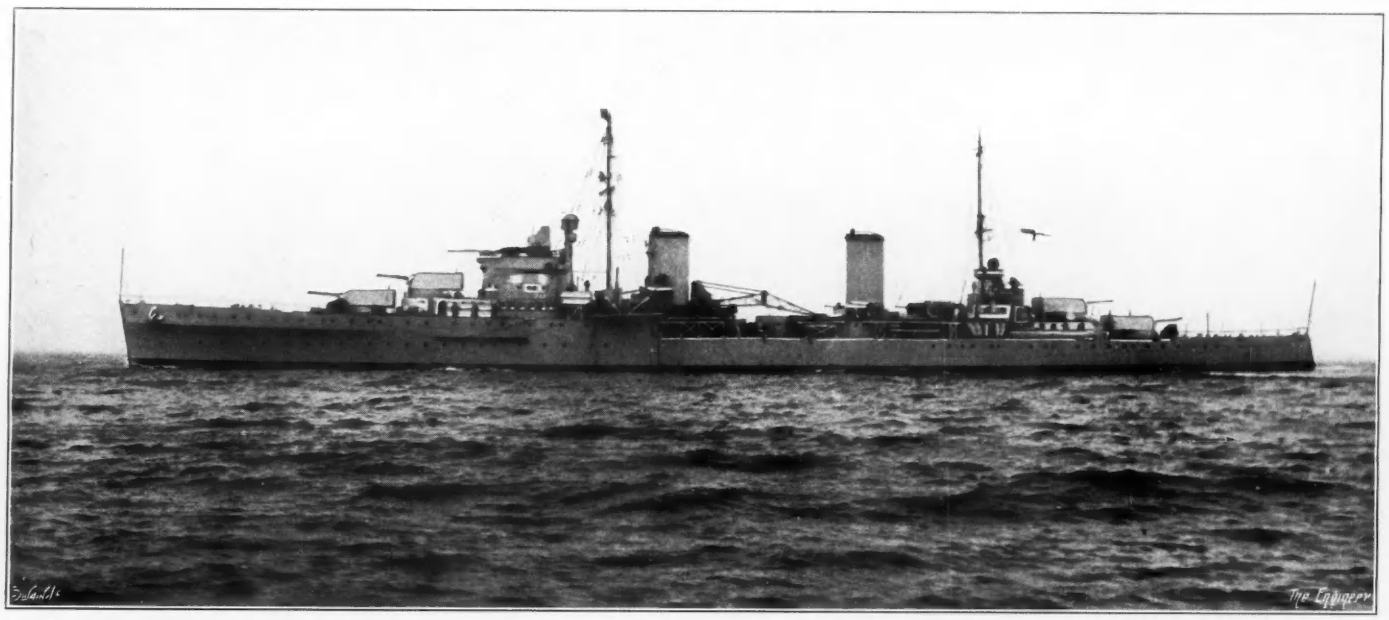


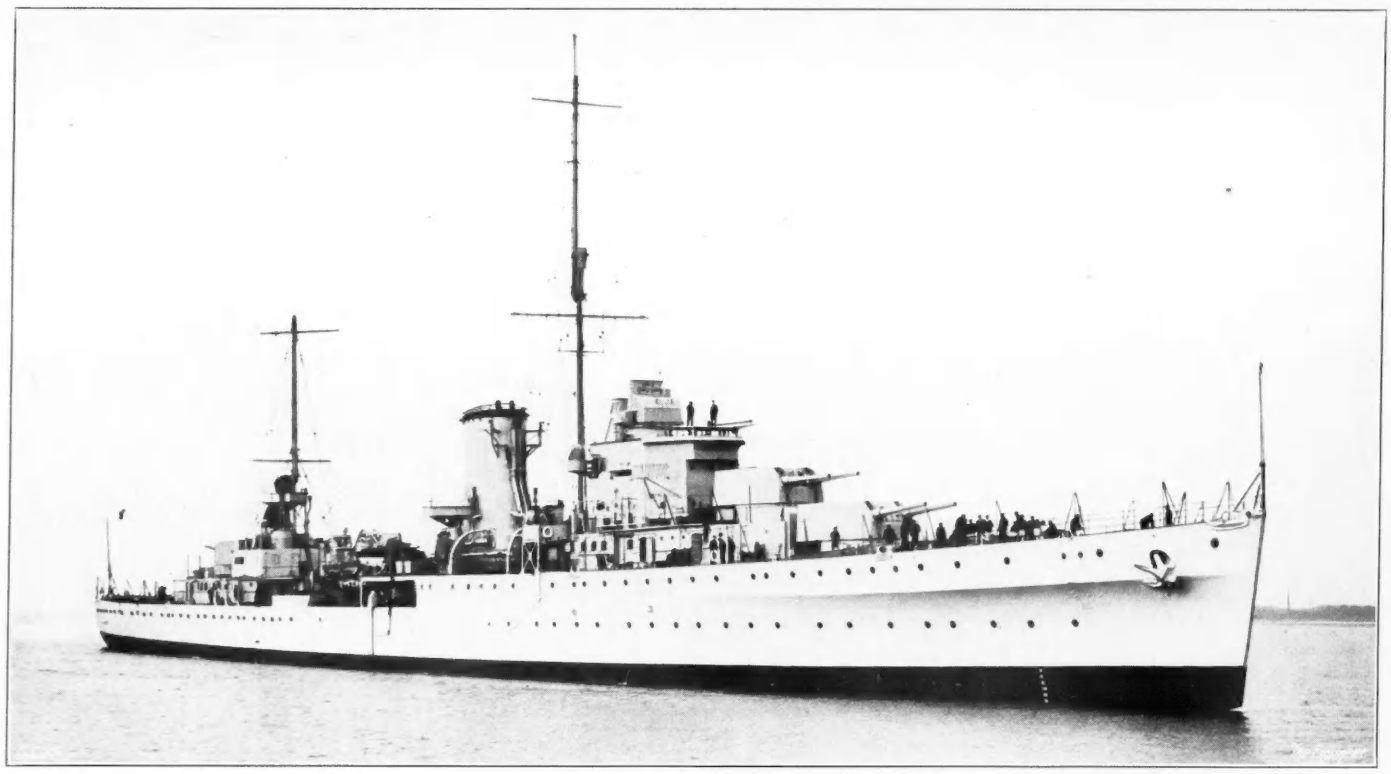


Bristol Transport Bomber Monoplane, Type 130
Westland "Wallace II" General Purpose Biplane
Fairey "Fantome" Multi-Gun Single-Seater Fighter

BRITISH WARSHIPS OF 1935

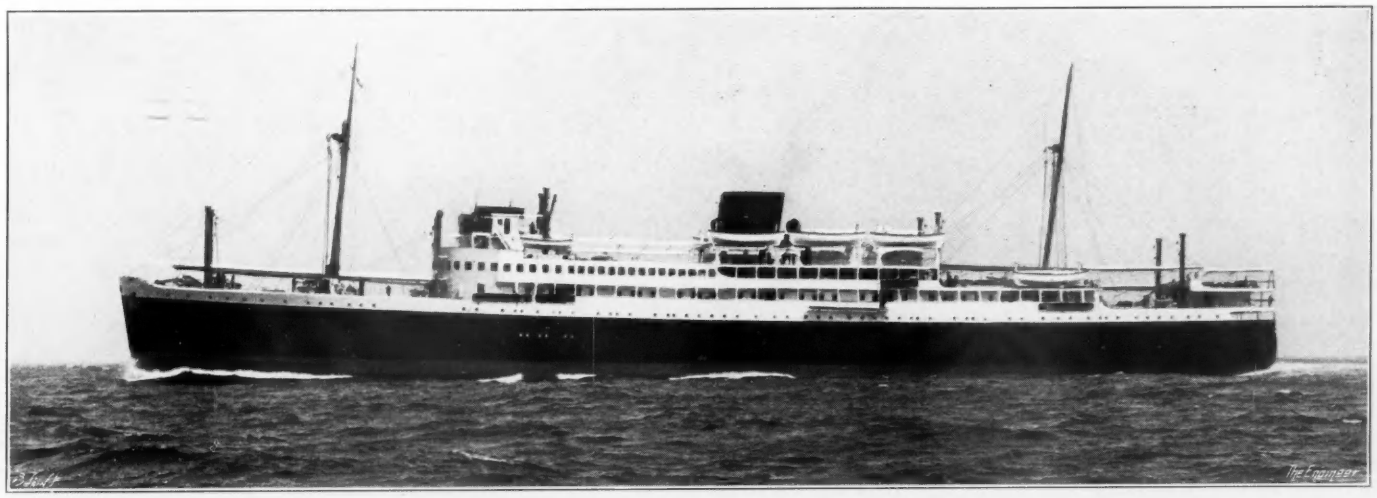


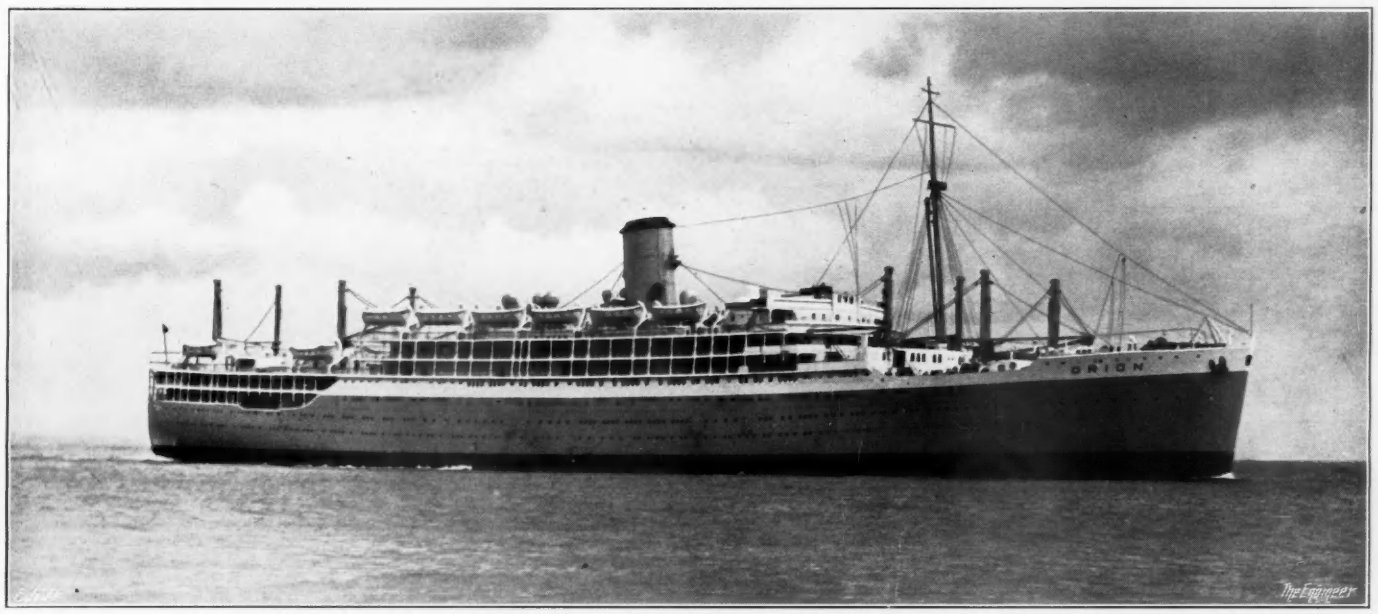


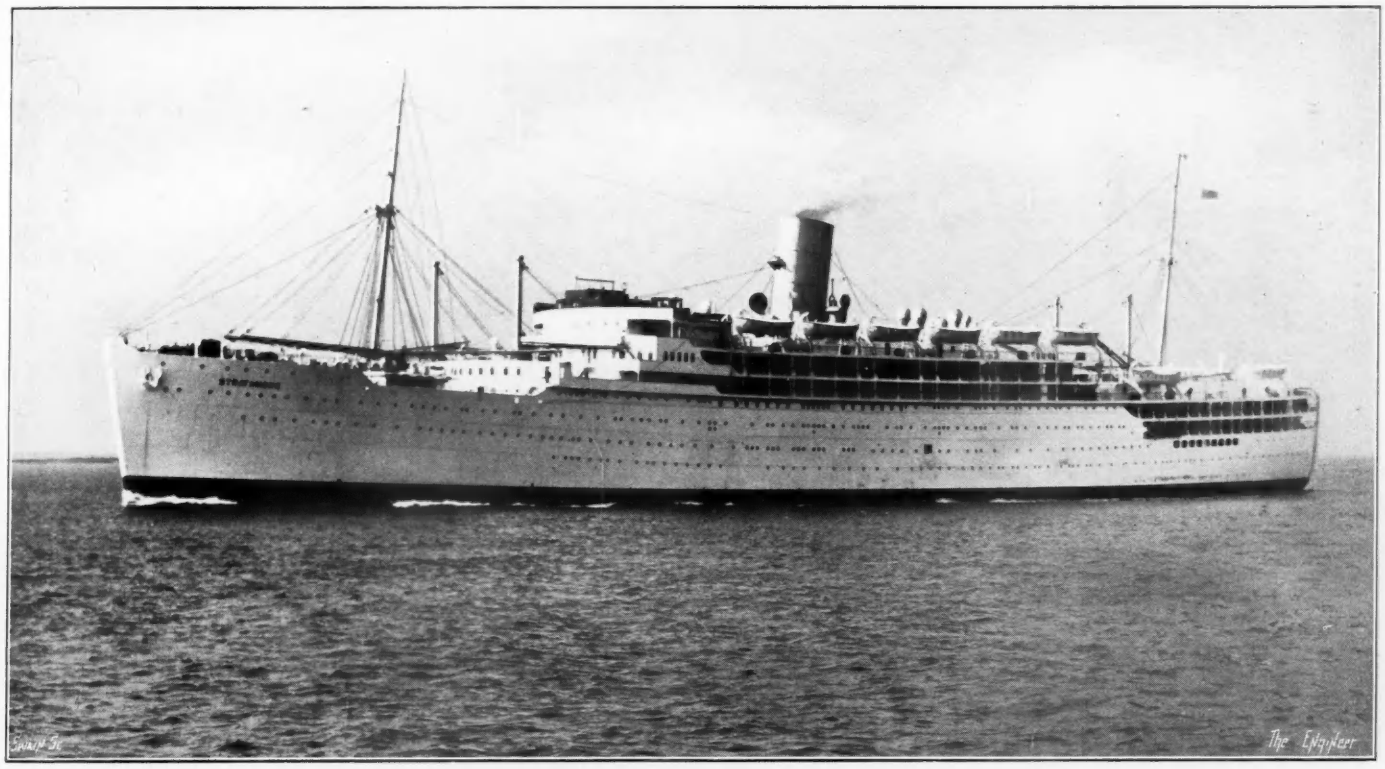


H.M. CRUISER "GALATEA"
H.M.A. CRUISER "SYDNEY"
H.M. CRUISER "AJAX"

MOTOR AND STEAMSHIPS OF 1935

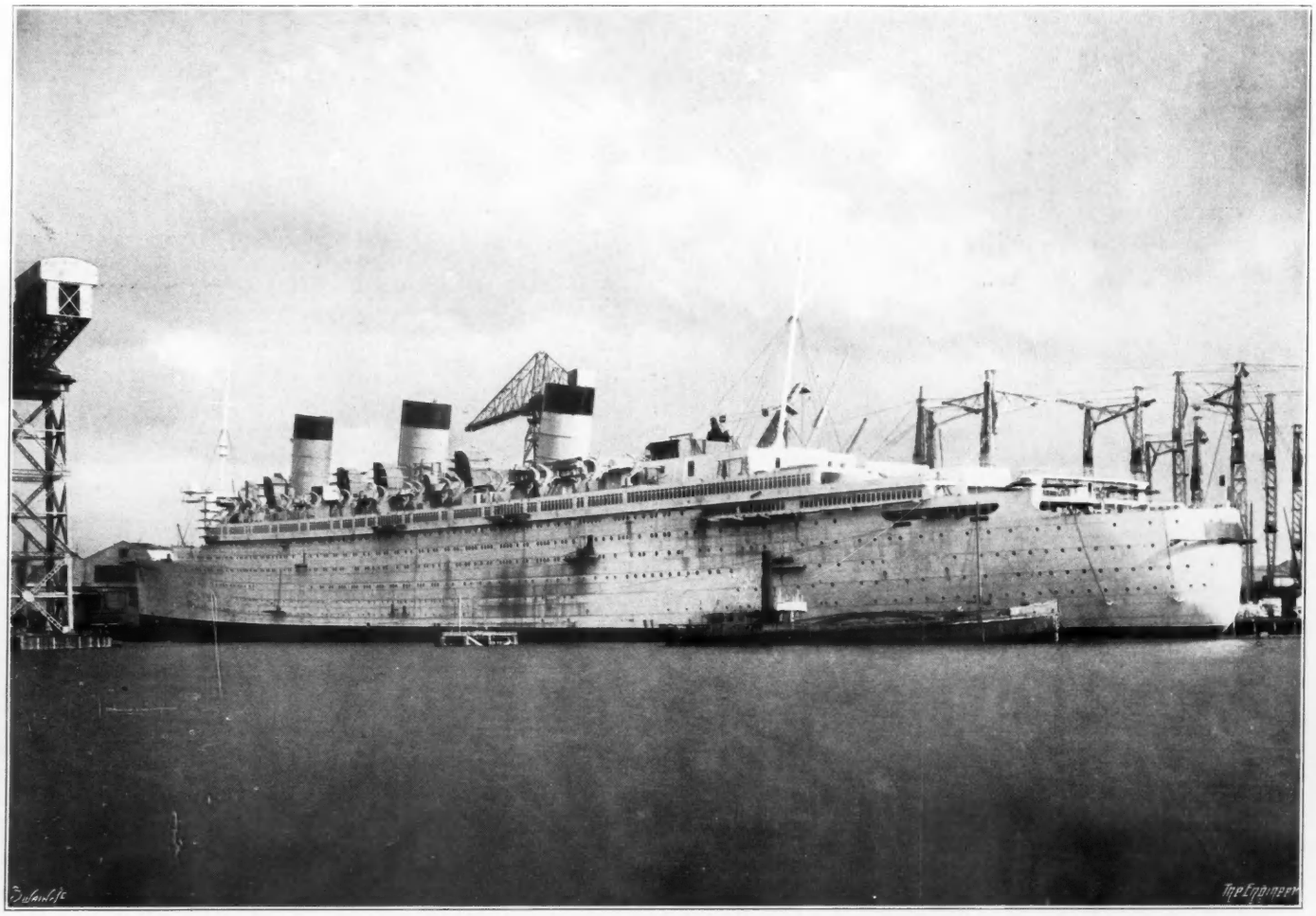


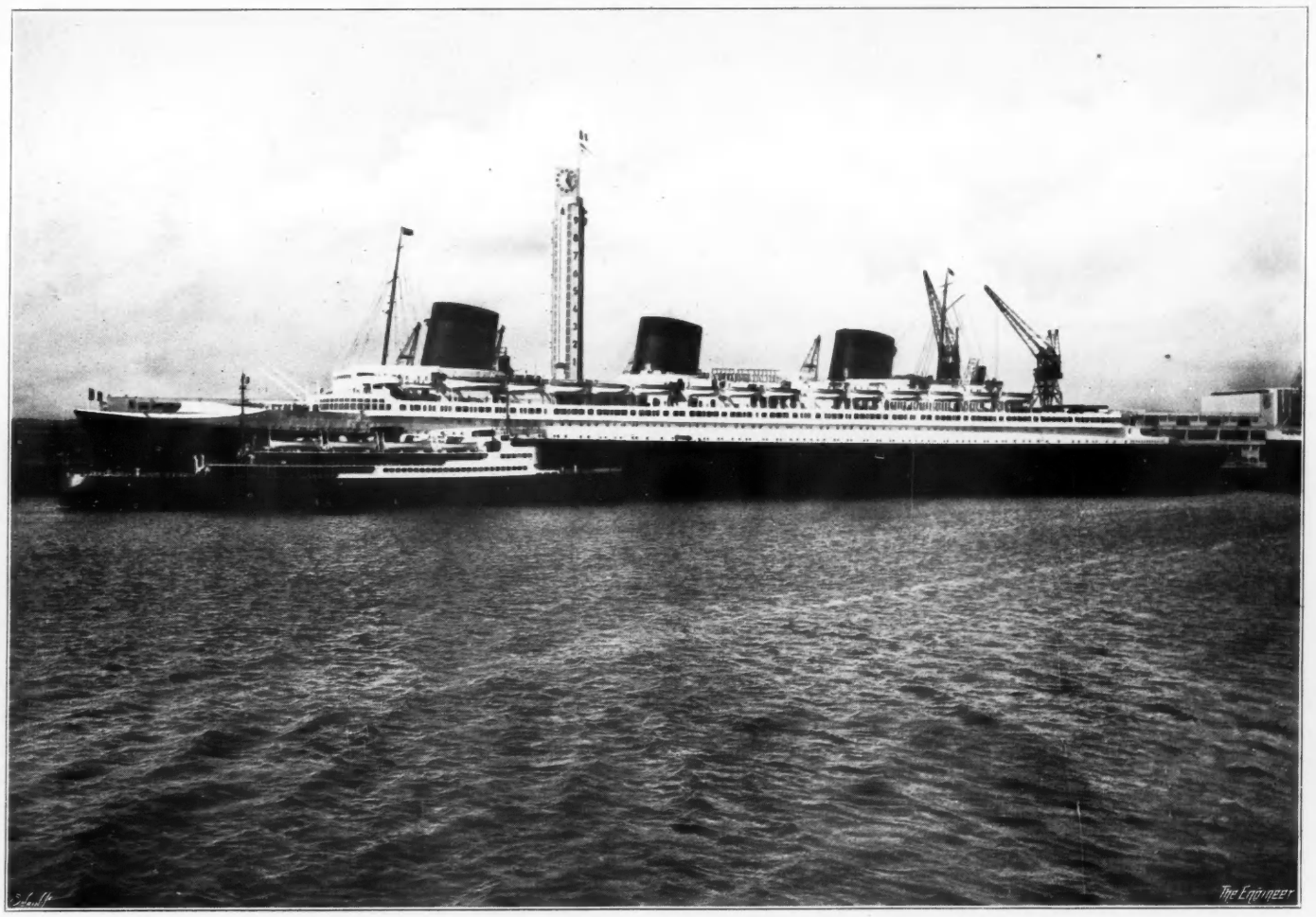




Melbourne Steamship Company's Motor Ship "Duntroon"
The Orient Liner "Orion"
The P. and O. Liner "Strathmore"

THE WORLD'S TWO LARGEST LINERS IN 1935



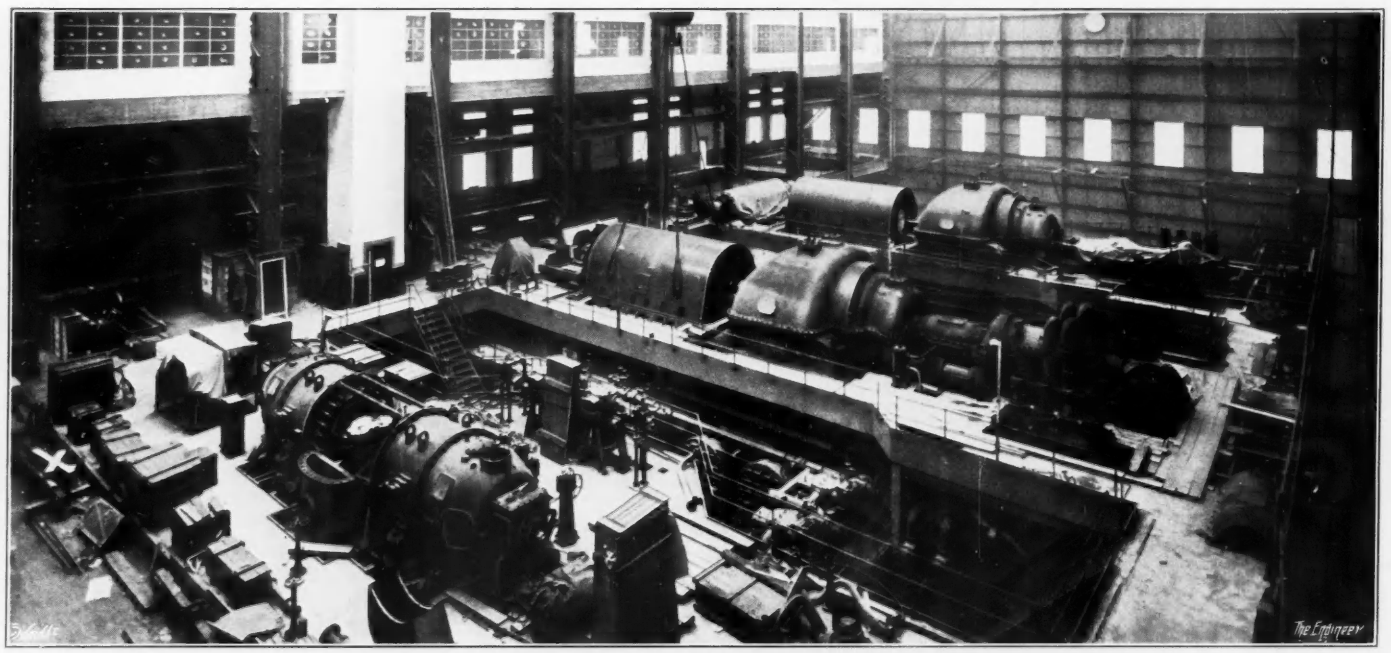


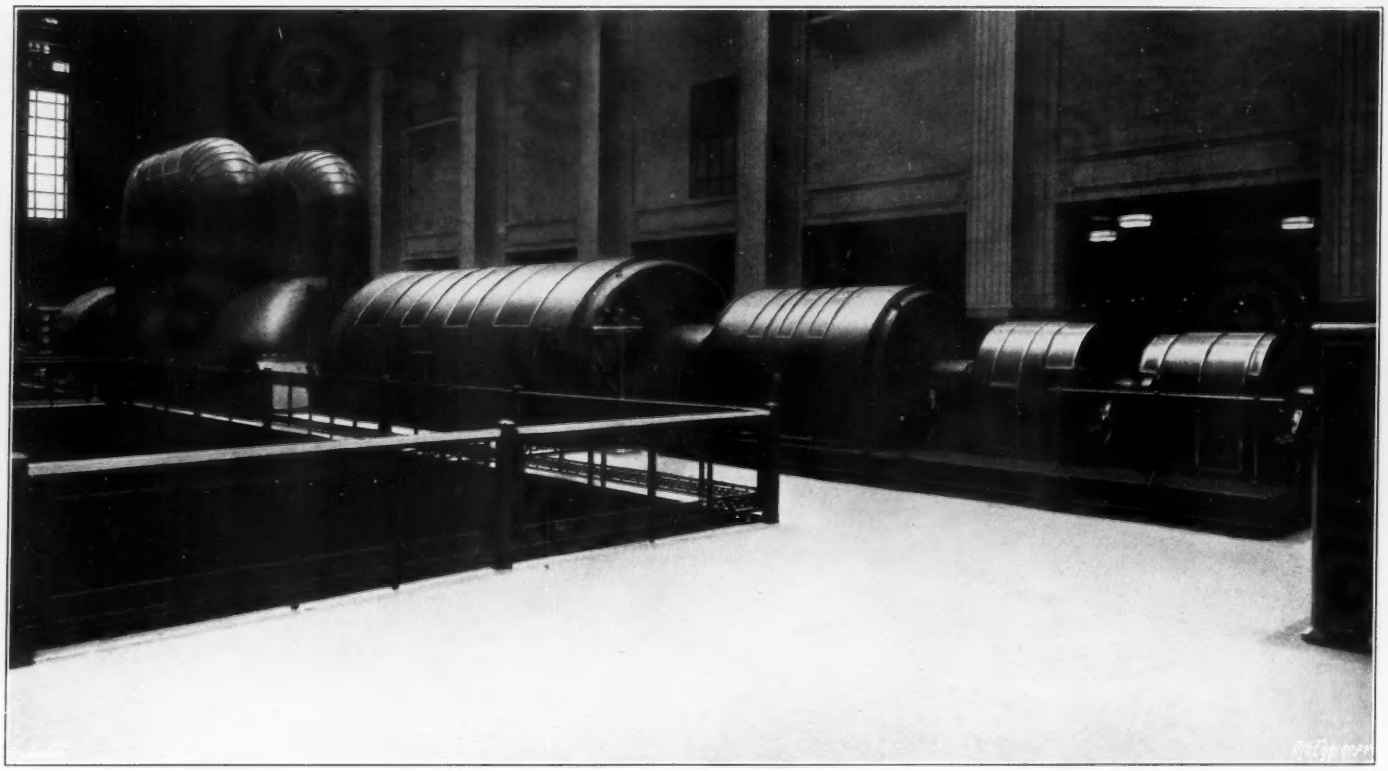
THE CUNARD-WHITE STAR LINER "QUEEN MARY" FITTING OUT AT CLYDEBANK
THE COMPAGNIE GENERALE TRANSATLANTIQUE LINER "NORMANDIE" AT LE HAVRE

TWO CIVIL ENGINEERING WORKS OF 1935

Chester - Holyhead Road, North Wales—The Penyclip Viaduct
State of Demolition of Waterloo Bridge in December

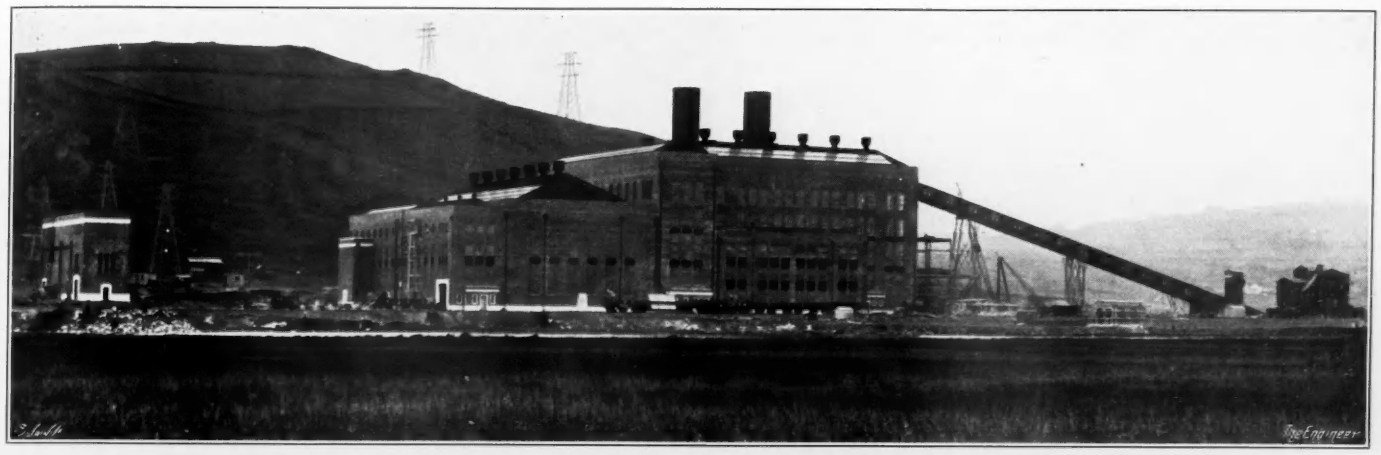
ELECTRIC POWER STATIONS OF 1935

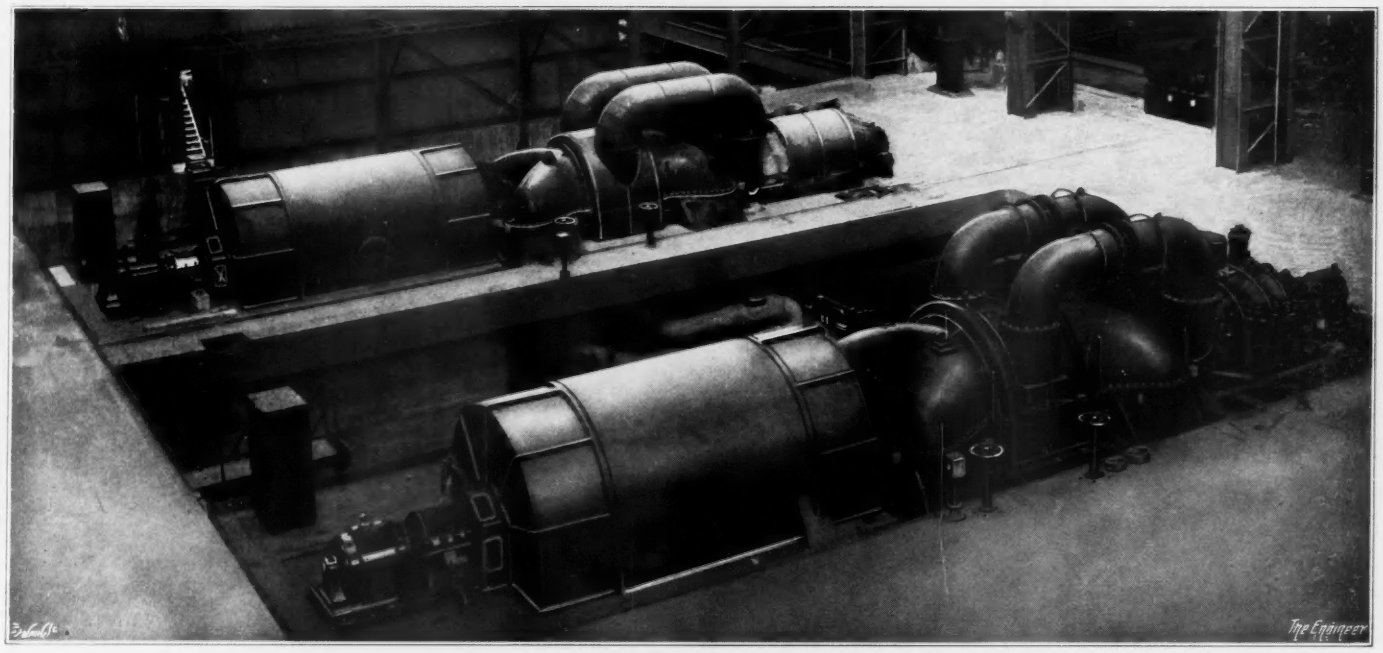


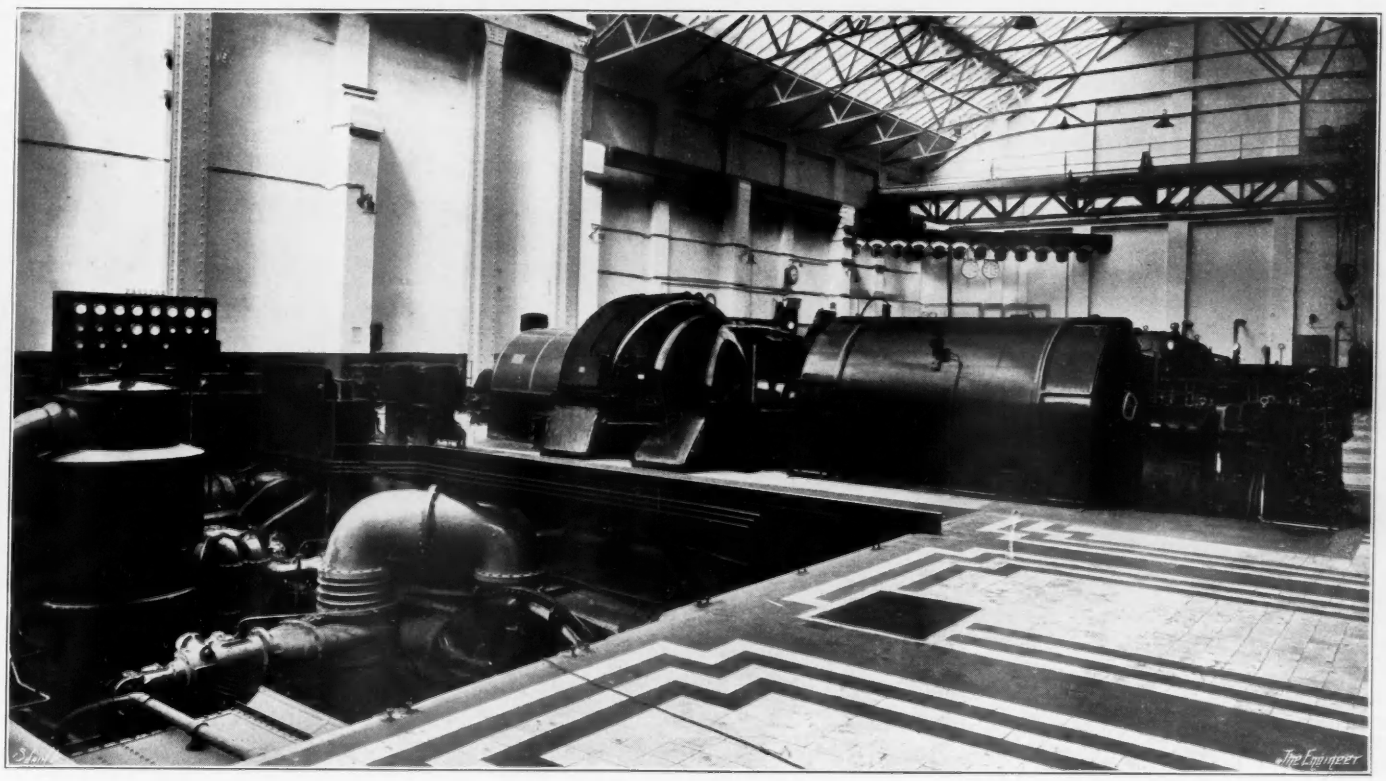


EXTERIOR VIEW OF FULHAM POWER STATION
TURBINE ROOM AT FULHAM POWER STATION
105,000 - kW TURBO - GENERATOR SET AT BATTERSEA POWER STATION

ELECTRIC POWER STATIONS OF 1935





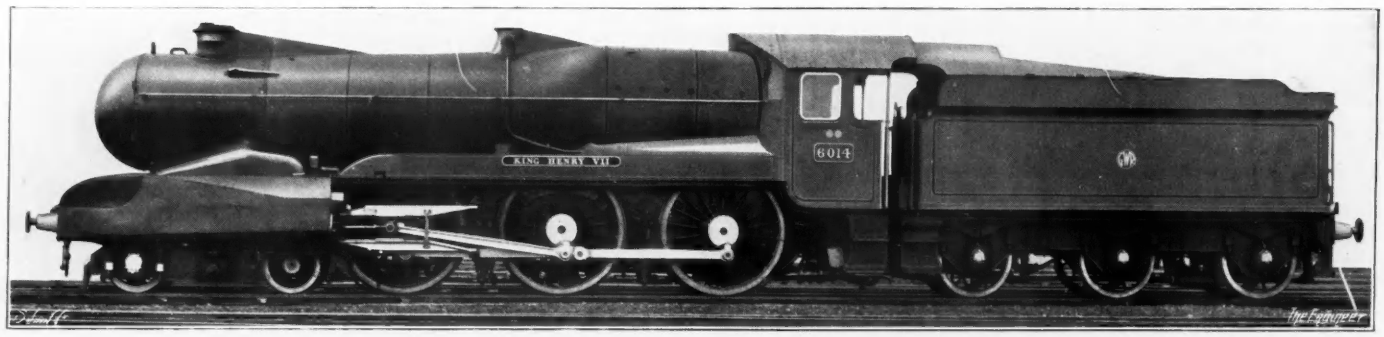


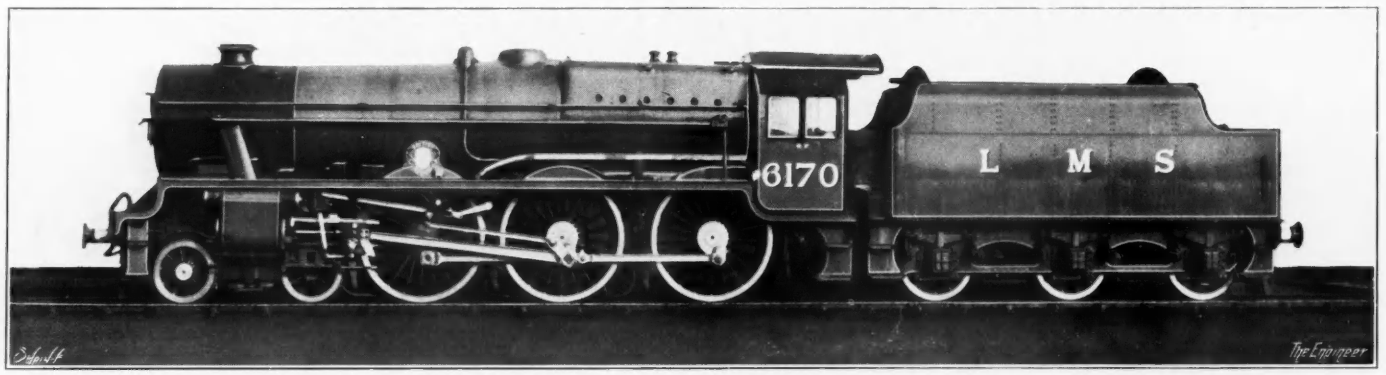
EXTERIOR VIEW OF TIR JOHN POWER STATION

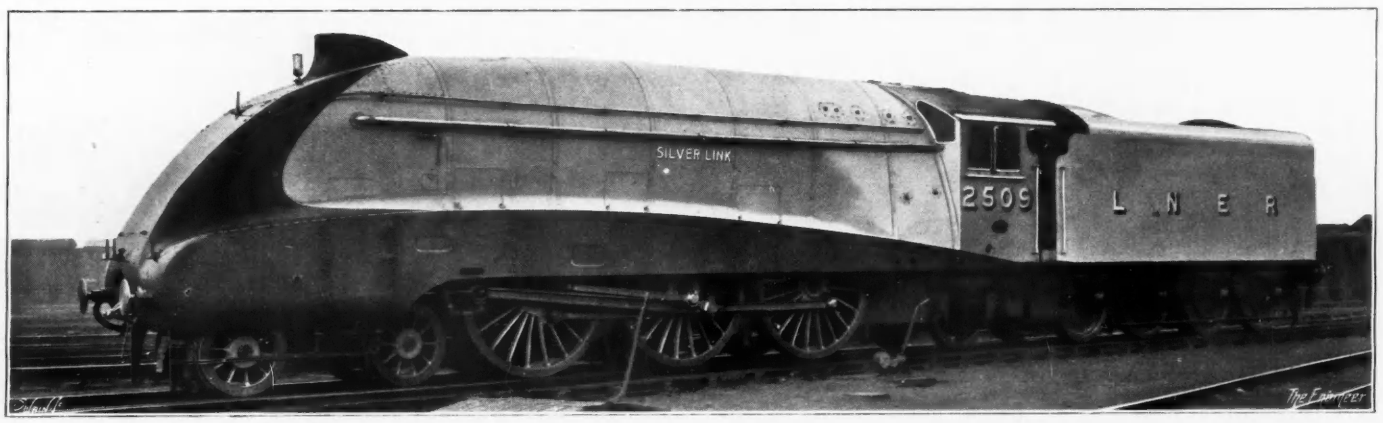
TURBINE ROOM AT TIR JOHN POWER STATION

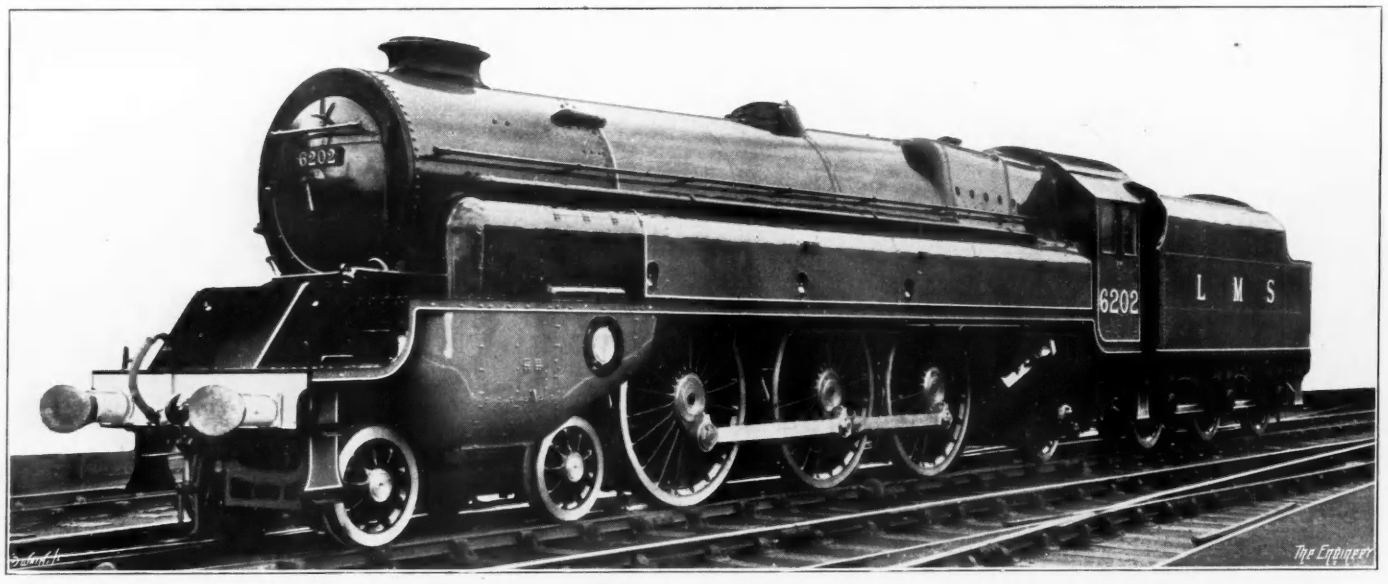
25,000-KW TURBO-GENERATOR SET AT HULL POWER STATION

BRITISH STEAM LOCOMOTIVES OF 1935







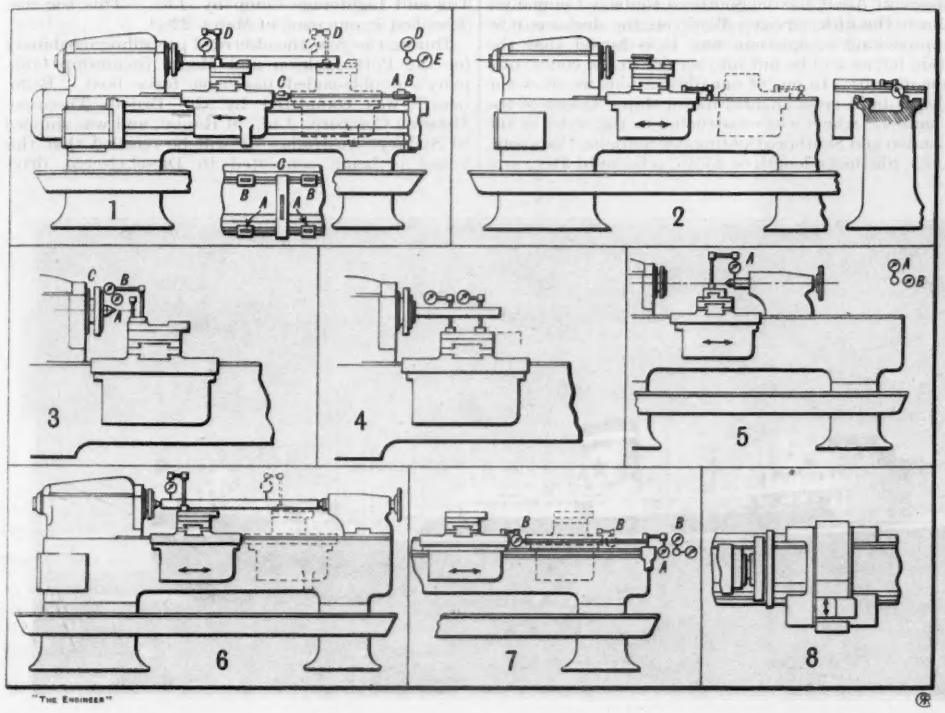


G.W.R.—STREAMLINED PASSENGER ENGINE
L.M.S.—REBOILERED PASSENGER ENGINE "BRITISH LEGION"
L.N.E.R.—HIGH-SPEED STREAMLINED ENGINE "SILVER LINK"
L.M.S.—NON-CONDENSING STEAM TURBINE EXPRESS ENGINE

of error are given in Fig. 10. As will be seen by reference to the figure, the limits allowed are, commercially considered, fine. But in cases where greater accuracy is required the firm invites particulars to be supplied, when it will put forward such special limits as may be necessary, a proposition that will probably appeal to many practical engineers.

The more recent activities of the firm are concerned with the Lang-Heinemann multi-cut lathe, an example of which was shown at the 1934 Olympia Exhibition, and the Wickman-Lang automatic, designed for the automatic production of screws, studs, and other components from bar material.

(To be continued.)



Measurement.		Max. limits of error.
Level on surface of bed, front shear	1A	+0·0005in.–0·0 on 3ft.
Level on surface of bed, back shear	1B	+0·0005in.–0·0 on 3ft.
Level across bed	1C	0·001in. on 3ft.
Parallelism of headstock spindle with surface of bed	1D	+0·0004in.–0·0 on 12in.
Parallelism of headstock spindle with bed in horizontal plane	1E	+0·0002in.–0·0 on 12in.
Parallelism of loose head guide with moving saddle	2	+0·0002in. on 3ft.
Fast head spindle concentricity on centre point	3A	0·0004in.
Fast head spindle concentricity on face of flange	3B	0·0002in.
Fast head spindle concentricity on location diameter or diameters	3C	0·0004in.
Parallelism of swivel slide to spindle	4	0·0005in. on 6in.
Parallelism of loose head spindle with surface of bed	5A	+0·0002in.–0·0 on 6in.
Parallelism of loose head spindle with bed in horizontal plane	5B	+0·0002in.–0·0 on 6in.
Parallelism of centre line with bed in vertical plane	6	+0·0002in.–0·0
Periodic error of screw	7A	0·0005in.
Screw parallel with bed	7B	0·002in.
Saddle square with fast head	8	+0·0–0·0005in. on 12in. dia.
Work turned concentric	—	0·0002in.
Work turned parallel	—	0·0004in. on 12in.

FIG. 10—LIMITS OF ERROR OF PRECISION LATHE

Shipbuilding & Marine Engineering in 1935

No I.

THE year 1935 in the shipbuilding and marine engineering industry was a period in which the industry as regards its shipbuilding and ship-repairing sections only marked time. The volume of work throughout the year barely allowed the merchant tonnage under construction to be maintained at about a half-million mark, or only about half of the amount of work in hand in 1929. At the end of 1935 there were about forty warships under construction in the private yards, five of which are for foreign countries, a position which is about the same as a year ago. At the beginning of the year about 30 per cent. of the berths were occupied and this percentage was maintained with difficulty throughout the year, but rose towards the end of the year. With the mercantile orders placed recently, and promised warship orders, it seems likely that the percentage of berths occupied may rise to the 50 per cent. level during the present year. The volume of employment in the industry during 1935 was practically the same as that during 1934, and the percentage of unemployed in the industry remained 2½ times as high as the general average for all other industries. There was a smaller amount of work booked for foreign account, and the industry suffered a severe loss, owing to the diversion to German shipyards of tanker and trawler orders for international trading companies, because British creditors found that in consequence of German Government restrictions against the export of funds, it was only possible to obtain direct payment of debts due by ordering ships from German yards.

The British Government's "scrap and build" scheme brought some benefit to North-East Coast shipyards. It must be admitted that shipowners in general have not yet given the scheme unanimous support. More orders from this source are awaited in the present year.

Ship-repairing, too, was carried on during 1935 under the same hard conditions as shipbuilding, and in this branch of the industry the effect of subsidised and uneconomic foreign competition on general price levels was keenly felt and still persists. In spite of the difficult position outlined a further effort on the part of the industry was made to eliminate its surplus capacity in an ordered and equitable manner. At its meeting held on September 19th it was announced that National Shipbuilders' Security, Limited, had purchased during its latest year of operation a further eight shipyards. Two of these yards, one on the North-East Coast and one on the Clyde, are being maintained by the company on a care and maintenance basis, whilst in another case the repairing part of the business is being carried on by a new firm. The recent purchases bring up the total number of building berths purchased by the company to 149, which represents an approximate annual output capacity of over 1,000,000 tons.

Although there are no startling new developments, either in hull or machinery design, to place on record, the trend of progress in the ships built last year is clearly discernible. We may remark in passing an increased use of the Maierform lines with the rising and sloping stern, and triangular-shaped forebody, which have given good results at sea and increased economy, both in the case of large liners and cargo ships and trawlers.

There was a marked tendency to standardise ship types, both for large food-carrying motor ships and oil-engined tramp vessels. The new cargo steamers now being built have been shown to be greatly superior to their predecessors and can often pay their way on services where older steamers can only be run at a loss. The improvements in hull forms, following tank experiments, and the adoption of modern propelling machinery have made it possible for British shipbuilders to offer modern cargo steamers designed to carry twice as much paying cargo for each ton of coal consumed as was possible with ships built eight to ten years ago. Whether in steam or oil-engine propelled ships, similar improved performances are now available over a wide range of ship types, which should encourage the further placing of orders.

The World's Two Largest Liners.

In one of to-day's Supplement pages we reproduce views of the world's two largest liners, the Compagnie Générale Transatlantique liner "Normandie" and the Cunard White Star liner "Queen Mary." The "Normandie" is shown at her home port of Le Havre, and alongside her is the Belgian cross-Channel motor ship "Prince Baudouin," a ship of about 3000 gross tons. The view of the "Queen Mary" is taken at the fitting-out basin at Clydebank, and shows the good lines of the hull. It is of interest to record that in the present year these two liners will operate in co-operation, and that agreement has been reached between the two companies in the matter of sailing schedules and passenger fares. The construction of the "Normandie" was fully described in our issues of May 31st and June 7th, 14th, and 21st, 1935.

On her maiden voyage from Le Havre to New York the "Normandie" gained the Blue Riband of the Atlantic by making the crossing from the Bishop Rock to the Ambrose Lightship in 4 days 3 h. 2 min. at an average speed of 29·98 knots. During the year a special Blue Riband Trophy was presented to the Atlantic shipping companies by Mr. H. Keats Hales, and this was presented to the "Normandie" on the occasion of her arrival in New York on October 23rd. A paper on the technical features of the ship was read by Monsieur Jean Marie, one of the directors of the C.G.T., at a joint meeting of the Institution of Mechanical Engineers and the British Section of the Société des Ingénieurs Civils de France on November 20th. In this paper reference was made to the vibration which had shown itself in the neighbourhood of the propellers. Later in the year special experimental runs were made in heavy weather in the Bay of Biscay with a view to overcoming the vibration troubles referred to and the pitting of the propeller blades due to erosion and corrosion. By making the two wing propellers of the ship turn inwards instead of all four propellers turning outwards, as originally designed a considerable reduction in vibration was, we understand, effected. By adopting this new arrangement of direction of rotation, together with a general stiffening of the hull, the provision of a new expansion joint, and the use of new propellers of modified design, it is confidently hoped to remove the vibration troubles, and the cavitation and erosion of propellers which showed themselves during the early running of the ship on a close schedule. The "Normandie" is expected to resume her Atlantic sailings at the end of March.

In the year under review good progress was made in the engining of the "Queen Mary" at Clydebank and the fitting out of her passenger accommodation, about 3000 workmen being employed on the ship. In the closing months of the year the machinery installation was completed, and the auxiliary boilers were fired to give heating steam as required. Early in the present month preparations will be made for carrying out the basin trials of the main propelling machinery and the auxiliaries and it is expected that the new liner will make her initial trip from Clydebank to Greenock about March 24th, after which speed trials in the Firth of Clyde will be carried out. A great deal of work has already been done by the Clyde Navigation Trust, and is still proceeding, in order to ensure a clear and safe channel for the ship. There is no doubt that the operation of these two large liners in Atlantic service during the year will furnish new and valuable data on the economics of Atlantic passenger transport. Until such data have been analysed it seems doubtful whether larger liners will be built. Towards the end of the year, however, Mr. Paul W. Chapman, a former president of the United States Lines, advocated the building of 100,000-ton liners of new design in America.

Outstanding British Liners.

Two of the most interesting liners built and put into service in 1935 were the P. and O. liner "Strathmore" and the Orient liner "Orion," which are shown in one of our Supplement pages. They were built and engined by Vickers-Armstrongs, Ltd., at Barrow-in-Furness and were fully described in our issues of August 23rd and 30th and September 20th and 27th respectively. They are ships of 24,000 gross tons with a length of 665ft., a beam of 82ft., and a depth of 47ft. 6in. to E deck, with a designed speed of over 20 knots. The propelling machinery comprises a twin-screw arrangement of Parsons single-reduction geared turbines with a designed output of 24,000 s.h.p., taking steam at 425 lb. pressure and

725 deg. Fah. from oil-fired Babcock and Wilcox water-tube boilers.

On her voyage to Bombay in November the P. and O. liner "Strathmore" made the trip from Marseilles to Bombay in ten days, at an average speed of 20·07 knots and an actual speed of 20·56 knots after clearing the Suez Canal. The previous best record was that of the Italian motor liner "Victoria," which took about eleven days for a transit of about 102 miles less from Genoa to Bombay. With the putting into service of the "Strathmore" the P. and O. liner "Mantua" was sold for breaking up. Other famous liners retired last year included the "Mauretania," the fame of which is to be preserved on shore by the erection of a Mauretania Hotel in New York. The "Olympic" has also been sold for breaking up, and it seems likely that the "Majestic" will be withdrawn from service during the present year.

In the early part of last year Harland and Wolff, Ltd., completed the re-engining of the Royal Mail liner "Alcantara," which was, like her sister ship the "Asturias," equipped with twin-screw Parsons single-reduction geared turbines, taking steam at 385 lb. pressure and 700 deg. Fah. from three Johnson water-tube oil-fired boilers manufactured under licence from Clarke, Chapman and Co., Ltd., by Harland and Wolff, Ltd. The "Alcantara" and the "Asturias" have throughout the year maintained an accelerated schedule of sailings with the utmost regularity.

Railway and Cross-Channel Steamers.

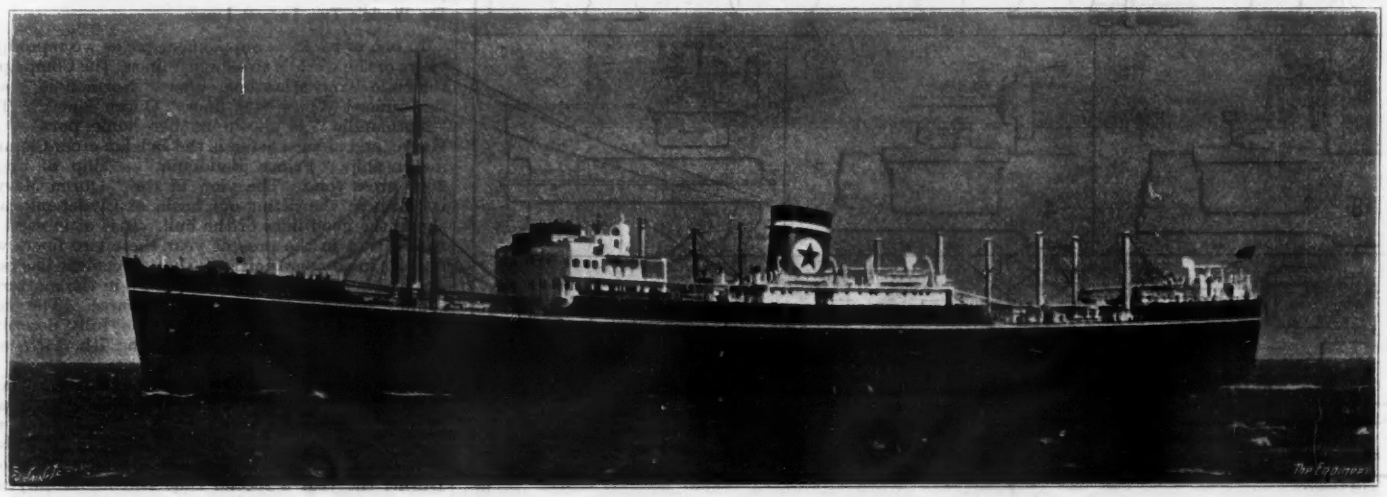
A noteworthy railway steamer of the year was the "Duke of York," which was built and engined by Harland and Wolff, Ltd., for the Heysham-Belfast service of the London, Midland and Scottish Railway Company. She has a measurement of 3700 gross tons with an overall length of 349ft., a beam of 52ft., and a depth to main deck of 19ft. 6in. The propelling machinery comprises a twin-screw arrangement of Parsons single-reduction geared turbines, taking steam from four Babcock and Wilcox stoker-fired boilers. During her trials the speed of 21 knots was exceeded and this new steamer has proved very popular in service. Railway steamers for Scottish service include the "Talisman," referred to under electrically propelled vessels. At Govan the Fairfield Shipbuilding and Engineering Company, Ltd., built the "Marchioness of Lorne," a paddle steamer for Clyde service. In last year's annual article we referred to the three cross-channel train ferries, designed and built under the supervision of Sir Westcott Abell, for the Southern Railway Company's Dover-Dunkirk service. Work on the docks is now approaching completion, and it is hoped that the train ferries will be put into service in the course of a few months. In one of our illustrations we show the Denny-built cross-channel motor ship "Queen of the Channel," which was constructed to the order of the London and Southern Continental Shipping Company, Ltd. She has a length of 255ft., a beam of 34ft., and a depth of 11ft. 6in., and is designed to carry about 1600 passengers. Her twin-screw Sulzer oil engines give a contract speed of 19 knots.

Electrically-Propelled Ships.

An interesting electrically propelled ship of the year was the L.N.E.R. oil-electric paddle vessel "Talisman," which was described and illustrated in our issue of July 5th. This ship is engaged on the railway company's Clyde estuary service from Craigendoran Pier. She has an overall length of 224ft. with a breadth of 27ft. 6in. and a maximum loaded draught of 6ft. 6in. The propelling machinery was supplied by the English Electric Company, Ltd., and comprises four 400 b.h.p., 600 r.p.m. oil engines driving generators which supply current to a 1300 s.h.p. motor directly attached to the paddle shafts. The ship has a designed service speed of 17 knots.

In a recent paper before the Institution of Electrical Engineers, Mr. G. A. Inglis gave a number of particulars with regard to the running of the ship. He stated that in the summer season the vessel ran regularly seven days each week and covered 10,120 nautical miles, an average of 110 miles daily, calling at more than thirty piers each day. The average consumption of fuel oil was 1·47 tons per 100 miles, including standby losses. This compares with 11½ tons of coal used in the same distance by her predecessor, a steamer of the same length, but 160 tons less displacement, and driven by a single engine with a haystack boiler. Four engines are used for express trips, but three are sufficient when the time-table is not exacting, and with only two engines a speed of over 14 knots can be maintained. The English Electric Company, Ltd., also supplied the electrical equipment for tin and other dredgers and for the Thames tug "Framfield," which was built by John I. Thornycroft, Ltd., for the services of the Thames Tug and Lighterage Company, Ltd. This tug was described in our issue of March 22nd.

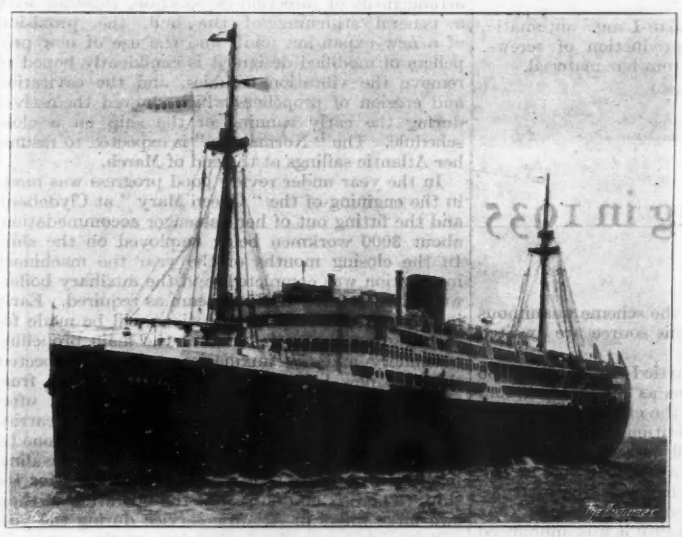
During the year the electrical propelling machinery for the Port Jackson and Manly Steamship Company's double-ended passenger ferry boat "Bellubera" was completed by the British Thomson-Houston Company, Ltd., of Rugby, and was shipped to Sydney, Australia. It will be recalled that this vessel is being converted to Diesel-electric drive with propelling machinery operated on the B.T.H. patented controlled-current system. The equipment for the vessel, for which the main contractors are the B.T.H. Company, comprises four five-cylinder Harland and Wolff two-stroke engines, each rated at 400/450 b.h.p. at 600 r.p.m., coupled to a B.T.H. D.C. generator rated 320 kW; four propeller motors each rated 615 h.p. at 790 r.p.m.; two sets of single-reduction, double-pinion, helical gears, and two bridge control stations.



BLUE STAR LINE M.V. "AUSTRALIA STAR"

Dredgers and Harbour Vessels.

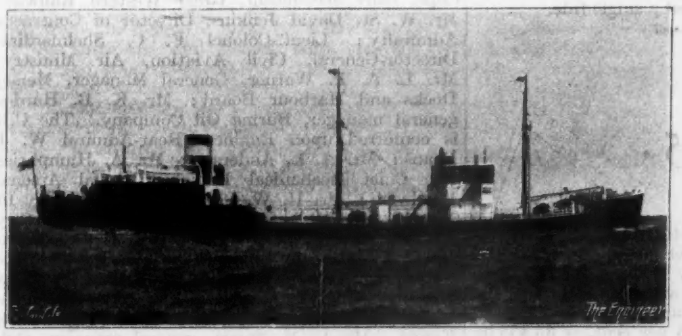
At Birkenhead, Cammell Laird and Co., Ltd., completed the suction dredger "Hoyle" for the Mersey Docks and Harbour Board, and delivered the motor vessels "Reculver" and "Strathearn" for the Corporation of Trinity House; also the tug "Grebe Cook" for the Liverpool Screw Towing and Lighterage Company. At Renfrew William Simons and Co., Ltd., built the "Onger," a drag and cutter suction hopper dredger, for work at Basrah, Iraq, and a pontoon for Colonial service, and also completed a small portable suction dredger. An interesting ship also completed by the firm was a diving bell barge for the Clyde Trust. The firm also supplied a quantity of dredging machinery. Lobnitz and Co., Ltd., of Renfrew, launched two gold dredgers, each of 1100 tons, with 900 i.h.p. machinery, and a twin-screw tug "Wm. C. Paldy," of 346 gross tons and 1500 i.h.p. for the Auckland Harbour Board, New Zealand, besides supplying machinery for foreign owners. At Paisley Fleming and Ferguson completed two non-propelling bucket dredgers with pump discharge for the Portuguese Government, and a bucket dredger "Woodbrook," which was



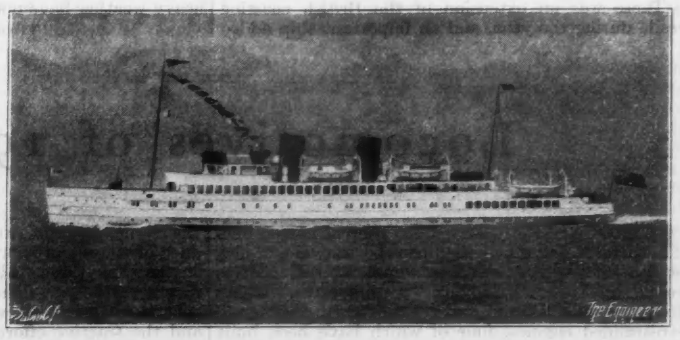
ELDER DEMPSTER MOTOR LINER "ABOSSO"

M.V. "PORT TOWNSVILLE"

specially designed for the Nash Dredging and Reclamation Company, Ltd., of London, for service in Trinidad. The firm also completed two small suction dredgers for India, and a vehicular ferry for Glasgow. The firm of Ferguson (Port Glasgow) Brothers, Ltd., Port Glasgow, also supplied some dredging machinery. In Aberdeen Alexander Hall and Co., Ltd., completed two hopper dredgers for London.



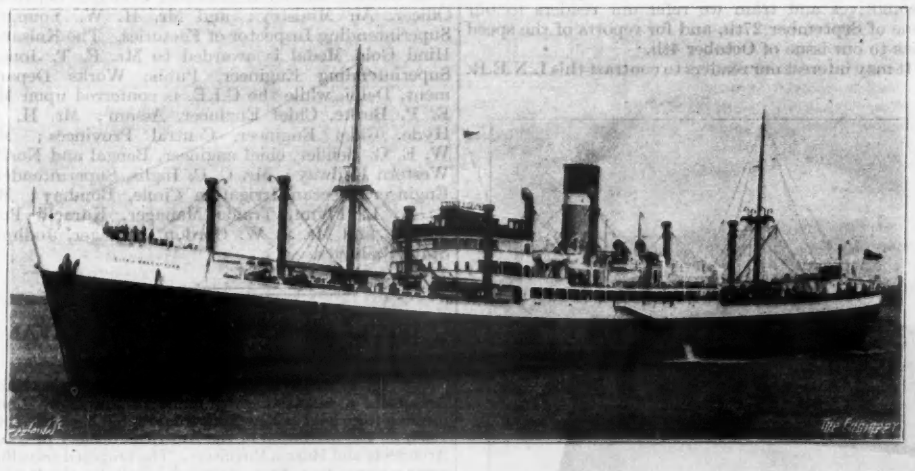
MOTOR TANKER "MOIRA"



CROSS-CHANNEL MOTOR-SHIP "QUEEN OF THE CHANNEL"

New Empire Food-Carrying Liners and Tramp Ships.

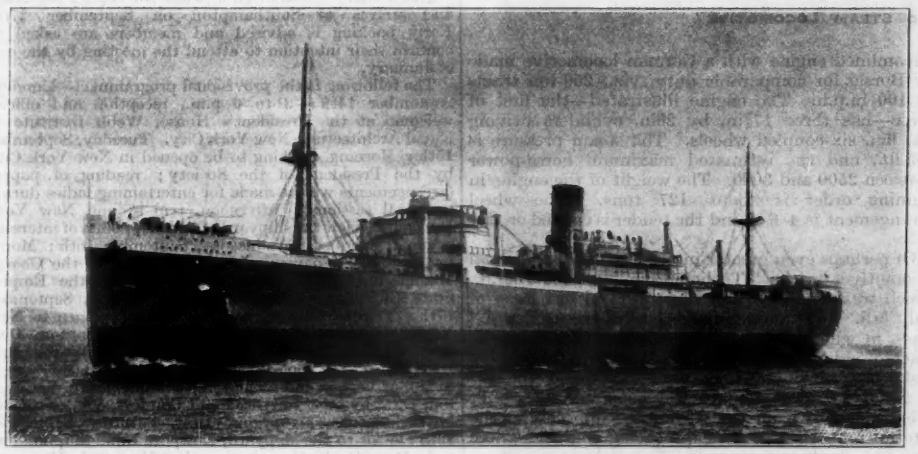
A notable motor ship of the year was the twin-screw passenger and cargo motor ship "Duntroon," illustrated in one of our Supplement pages, which was built by Swan, Hunter and Wigham Richardson, Ltd., and left the Tyne at the end of July to enter the coasting service of her owners, The Melbourne Steamship Co., Ltd., of Melbourne, Australia. She is a 10,335 gross ton ship, with a length of 472ft., and a beam of 65ft. Her propelling machinery is designed for a contract speed of 16¾ knots and comprises a twin-screw arrangement of Harland-Kincaid-B. and W. type double-acting two-stroke oil engines. On her trial trip a speed of 19 knots was attained. Other Australian and New Zealand ships of the year included the "Port Townsville," also a Swan-Hunter ship, which has a length of 516ft. and a breadth of 65ft., with a measurement of 8860 gross tons. She is a sister ship to the "Port Wyndham," built for the same owners, which is illustrated herewith. The "Port Wyndham" was built by John Brown and Co., Ltd., at Clydebank, and is propelled by Brown-Doxford oil engines.



ELLERMAN LINES S.S. "CITY OF MANCHESTER"

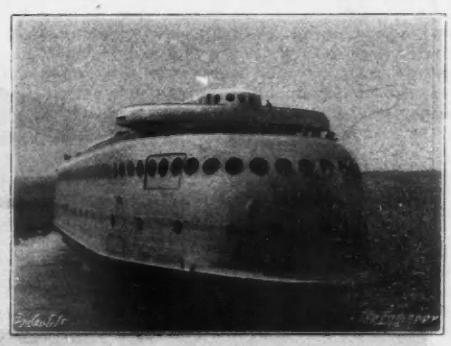
Among the fast refrigerated motor cargo ships built and engined by Harland and Wolff, Ltd., at Belfast may be mentioned the "Wairangi," the last of three ships constructed for the New Zealand trade of Shaw, Savill and Albion, Ltd. Following the delivery of the "Empire Star" last year there were also completed at Belfast the Blue Star Line refrigerated motor ships "New Zealand Star" and "Australia Star." One of our illustrations shows the last-named ship. She has a length of 535ft. 6in. with a beam of 70ft. and a depth to the weather deck of 43ft. 3½in. Her measurement is 11,122 gross tons and her propelling machinery is of the Harland-B. and W. two-stroke twin-screw type, the total output being 12,000 s.h.p. at 95 r.p.m. The refrigerating machinery is driven by Brush oil engines and was supplied by the Liverpool Refrigeration Company, Ltd. At Birkenhead Cammell Laird and Co., Ltd., launched the "Dunedin Star."

An important addition to the Union Castle South African fleet was made during the year by the delivery by Harland and Wolff, Ltd., of the two refrigerated motor cargo liners "Rothesay Castle" and "Roslin Castle." They are 440ft., 7000 gross ton vessels, propelled by single eight-cylinder double-acting Harland and Wolff engines with a designed output of 8650 i.h.p. Refrigerating machinery by J. and E. Hall is fitted in these ships. The two new Royal Mail passenger and cargo liners "Athlone Castle" and "Stirling Castle" were launched. These ships are the largest vessels after the "Queen Mary" under construction in British yards and have a gross tonnage of 25,000 tons. They will be propelled by twin-screw Harland-B. and W. ten-cylinder engines working on the two-stroke double-acting principle, with a total designed output of 28,500 i.h.p. These units are among the largest of the type yet built. Another Belfast built ship was the motor liner "Calabar," for the Nigerian coastal service of the Elder Dempster Lines, Ltd. Another ship for the same owners was the motor liner "Abosso," constructed by Cammell Laird and Co., Ltd. A view of this ship is shown herewith. She has a measurement of 11,329 gross tons and is propelled by twin-screw Kincaid-B. and W. oil engines with a designed output of 10,500 i.h.p. Another Cammell-Laird built ship which we illustrate is the "City of Manchester," belonging to the Ellerman Lines and used in the company's Australian service. She is a 9000 gross ton ship and is propelled by twin-screw Parsons single-reduction turbines, taking steam from 275 lb. pressure boilers working under Howden's forced draught system.



M.V. "PORT WYNDHAM"

On the Clyde Barclay, Curle and Co., Ltd., completed the motor ship "Hopecrest" for the Hopemount Shipping Company, Ltd., and the "Dilwara," a passenger and cargo and troop-carrying ship for the British India Steam Navigation Company, Ltd., was also prepared for trials. A description of the



STREAMLINED FERRY "KALAKALA"

machinery of this vessel was given in our issue of November 1st last. At Govan Alexander Stephen and Sons, Ltd., completed the "Manoora," a 17-knot 10,855 gross ton motor ship, for the Adelaide Steamship Company, of Australia. She is propelled by twin-screw Kincaid-B. and W. pressure charged oil engines of 10,500 i.h.p. total. During the year William Doxford and Sons, Ltd., delivered a number of standard motor cargo ships of about 4970 gross tons register, all of which were driven by a single-cylinder opposed-piston balanced oil engine of 2100 i.h.p. In Glasgow the Fairfield Shipbuilding and Engineering Company, Ltd., completed a new Bibby motor liner, the "Derbyshire." She is a 500ft., 13,000 gross ton passenger and cargo liner and is propelled by twin-screw Fairfield-Sulzer oil engines of 8000 b.h.p. total output.

Oil Tankers and Coastal Ships.

The past year was noteworthy for large motor oil tanker programmes of construction, orders being placed by the Anglo-Saxon Petroleum Company, Ltd., the Eagle Oil and Shipping Company, Ltd., and British Tankers, Ltd., of London. These were distributed among the various British yards and some of the Anglo-Saxon tankers were built abroad. Six of the 11,000-ton, 12½-knot Eagle oil tankers and several of the 12,100-ton, 12½-knot Anglo-Saxon tankers were completed during the year. In November last the Anglo-American Oil Company, Ltd., placed an interesting order with John Brown and Co., Ltd., for a motor tanker specially designed to carry lubricating oils of twenty-seven different grades. The ship will have a speed of 13 knots loaded and will be propelled by a Brown-Doxford 3300 b.h.p. oil engine of welded form construction.

On the Tyne Swan, Hunter and Wigham Richardson, Ltd., built the all-welded tanker "Moira" for

the Marna Company, of Oslo. She is shown in the accompanying engraving and she has a length of 245ft. and a deadweight carrying capacity of 2240 tons. A novel motor ferry is the M.S. "Kalakala" built by the Puget Sound Navigation Company, of Seattle, Washington. She has a length of 276ft., a beam of 55·8ft. and a passenger capacity for 2000 persons and takes 110 motor cars. She is propelled by Busch-Sulzer engines of 3000 h.p. total.

There was an extension of the British coasting trade during the year, and an important ship added to the fleet of Coast Lines, Ltd., was the motor vessel "Ocean Coast," built by Henry Robb, Ltd., of Leith, and equipped with twin-screw Polar engines of 750 b.h.p. each. The "Ocean Coast" has a length of 250ft. and a deadweight carrying capacity of 1700 tons. She is designed to carry twelve passengers. It is of interest to record that the earlier ships, the "British Coast" and the "Atlantic Coast," have proved very satisfactory in operation and in spite of heavy weather have not missed a single tide.

(To be continued.)

Locomotives of 1935.

ALTHOUGH the year was far from a barren one, there is not much that can be said about new steam locomotives. The principal interest centres round the L.M.S.-Metrovick "Turbomotive," which took the rails in July, and the L.N.E.R. completely streamlined engines, four of which have been built for the London and Newcastle service. A trial run of the first engine, "Silver Link," with a completely new train, the "Silver Jubilee," took place on September 27th. Mr. Collett has also been studying the question of streamlining, and has reduced the head-on resistance of some of his "Kings" by fitting fairings behind the chimney and whistle, doming the smoke-box cover, and shrouding the cylinders. All these engines and the "British Legion," of the L.M.S., which is of particular historical interest, are shown in one of our special Supplements. They have been described in our pages, but it may be a convenience to some of our readers if we give a few notes and particulars about each.

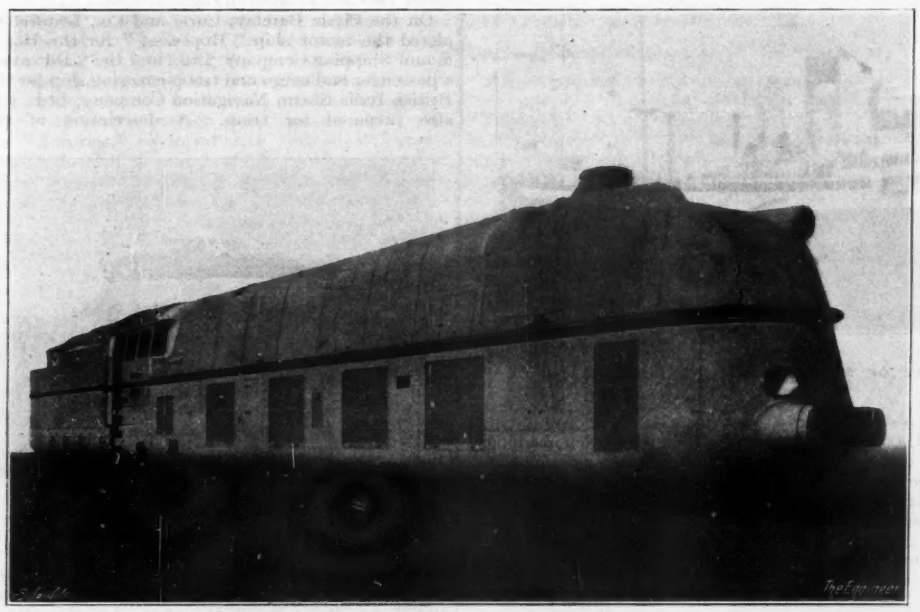
Taking first the Great Western engine, it can be dismissed in two words, for the illustration shows the essential features. Mr. Collett, like Mr. Gresley, is not prepared to speak on the value of streamlining until extended experience has been gained. The L.M.S. "British Legion" is an engine of the "Royal Scot" three-cylinder class, fitted with a tapered boiler and brought up to date by other details. It is numbered "6170." The most notable change is the increase of the fire-box heating surface from 189 square feet—standard for the original "Royal Scots"—to 195 square feet. The tube heating surface has been reduced from 1892 to 1669 square feet, and the superheater surface from 399 to 360 square feet. The total evaporative surface is now 1864, as against 1892 in the original engines; the pressure remains 250 lb. and the tractive effort 33,150 lb. The conversion was carried out at Crewe. What must be regarded as perhaps the last public action of the late Admiral of the Fleet, Lord Jellicoe, was the naming of this engine at Euston on November 12th. He died a week later.

To the first of Mr. Gresley's new engines belongs the distinction of reaching the highest speed with a full train ever attained on a British railway. On Friday, September 27th, the "Silver Jubilee" train of seven coaches with a gross loaded weight of 230 tons behind the tender, indicated a speed of 112 miles per hour twice on a speedometer in the van, once near Arseley and once between Biggleswade and Sandy, whilst a distance of 25 miles—roughly Hitchin to Offord—was covered at 107·5 miles per hour. How much of this remarkable turn of speed is to be attributed to the mechanical design of the locomotive and how much to the streamlining of the engine and the attempts to reduce the air resistance of the train, it is not yet possible to say. The engine has three 18½in. by 26in. cylinders, with piston valves 9in. diameter, and a cut-off of 65 per cent. in full gear; the wheels are 6ft. 8in. in diameter, and the tractive effort at 85 per cent. is 35,455 lb. The fire-box has 231·2 square feet of heating surface, and the total evaporative surface is 2576 square feet. The grate area is 41·25 square feet, and the pressure 250 lb. The blast pipe nozzle is 5¼in. in diameter and is fitted with a Churchward jumper ring to relieve back pressure when working at a late cut-off. The engine weighs nearly 103 tons with 22 tons on each of the three coupled axles.

The train itself is an admirable example of recent tendencies in express design. It is one of four which have established a service of four hours between London and Newcastle—268 miles—including one stop—at Darlington. For a full description of the locomotives and train we refer our readers to our issue of September 27th, and for reports of the speed tests to our issue of October 4th.

It may interest our readers to contrast this L.N.E.R. streamlined engine with a German locomotive made by Borsig for comparable duty, viz., 250-ton trains at 100 m.p.h. The engine illustrated—the first of three—has three 17¾in. by 26in. cylinders driving 7ft. 6in. six-coupled wheels. The steam pressure is 295 lb., and the estimated maximum horse-power between 2500 and 3000. The weight of the engine in running order is about 127 tons. The wheel arrangement is 4–6–4 and the tender is carried on five axles.

Of perhaps even greater interest than these normal locomotives is the "Turbomotive" on the L.M.S., which was described and illustrated in our issue of July 5th. It is an engine of the "Princess Royal" class, in which turbines and reducing gear take the place of cylinders and motion. It is non-condensing and a variable double blast pipe in a double chimney is fitted to accommodate the constant stream of exhaust steam from the turbine as opposed to the intermittent blast of a reciprocating engine. There are two turbines, that for forward-running permanently keyed to the reducing gear, whilst the reverse turbine is clutched in when required. The final drive to the wheel is through a quill as in electric locomotive practice. The forward turbine is designed for 2000 h.p., with a back pressure as low as 2 lb. per square inch. The engine has been designed to haul 500-ton trains between Euston and Glasgow, and during experimental service gave very promising economic results. She is at present being overhauled and certain improvements indicated in actual work are being incorporated.



BORSIG 4-6-4 STREAMLINED STEAM LOCOMOTIVE

New Year Honours.

BELOW we give some of the names which appear among the New Year Honours bestowed by the King. Knighthoods are conferred upon Mr. T. Biggart, formerly secretary of the Shipbuilding and the Engineering Employers' Federation; Mr. R. Cope, chief accountant, Great Western Railway; Mr. W. St. David Jenkins, Director of Contracts, Admiralty; Lieut.-Colonel F. C. Shelmerdine, Director-General, Civil Aviation, Air Ministry; Mr. L. A. P. Warner, General Manager, Mersey Docks and Harbour Board; Mr. K. B. Harder, general manager, Burma Oil Company. The C.B. is conferred upon Engineer Rear-Admiral W. J. Deans; Mr. A. L. Anderson; Mr. A. Humphries, late Chief Mechanical Engineer, Royal Arsenal, Woolwich; Mr. H. W. Cole, Deputy Secretary for Mines; and Mr. A. T. Robinson, Deputy Secretary, Ministry of Transport. The C.B.E. is awarded to Mr. C. J. McKenzie, Engineer-in-Chief, Public Works Department, New Zealand; Mr. S. P. Flowerdew, Executive Engineer, Northern Extension, Nyasaland Railway; Mr. H. L. Sikes, Director of Public Works, Kenya; Mr. L. M. Smart, general manager, Gold Coast Railway; Mr. F. R. E. Davis, secretary, Great Western Railway; and Mr. A. J. Martin, Assistant Comptroller, Patent Office. The O.B.E. is awarded to Mr. W. Y. Robinson, Chief Engineer, Public Works Department, Newfoundland; Mr. L. Oury, for services in connection with the Zambesi Bridge; Mr. J. W. Johnstone, Chief Factory Inspector, Bombay; Engineer Commander V. D. Nops; Mr. T. Crook, Principal, Mineral Resources Department, Imperial Institute; Mr. J. F. Lean, principal assistant general manager, Great Western Railway; Mr. C. J. Mercer, Staff Engineer, General Post Office; Mr. H. L. Stevens, Principal Scientific Officer, Air Ministry; and Mr. H. W. Younger, Superintending Inspector of Factories. The Kaisar-i-Hind Gold Medal is awarded to Mr. F. T. Jones, Superintending Engineer, Public Works Department, Delhi, while the C.I.E. is conferred upon Mr. E. P. Burke, Chief Engineer, Assam; Mr. H. A. Hyde, Chief Engineer, Central Provinces; Mr. W. E. G. Bender, chief engineer, Bengal and North-Western Railway; Mr. C. C. Inglis, Superintendent Engineer, Deccan Irrigation Circle, Bombay; Mr. A. A. L. Flynn, Traffic Manager, Karachi Port Trust; and Mr. J. W. Gordon, Manager, Jodhpur State Railways.

INTERNATIONAL MEETING OF NAVAL ARCHITECTS IN NEW YORK.

WE have received from the Institution of Naval Architects a tentative programme of the international meeting to be held in New York from September 14th–19th, 1936, on the invitation of the American Society of Naval Architects and Marine Engineers. The proposed travelling arrangements have been arranged jointly by the Institution of Naval Architects, the Institution of Engineers and Shipbuilders in Scotland, the North-East Coast Institution of Engineers and Shipbuilders, and the Institute of Marine Engineers. Both members of the Institutions and ladies are invited to attend, and preliminary arrangements have been made as follows:—Going by a cabin-class ship (m.s. "Britannic") and returning first-class by the s.s. "Queen Mary" will cost, say, £75, while going and returning by a cabin-class ship will cost, say, £60. The dates of sailing as at present fixed are:

M.s. "Britannic" leaves Southampton September 5th and arrives in New York September 13th. The s.s. "Queen Mary" leaves New York on September 23rd, and arrives at Southampton on September 27th. Early booking is advised and members are asked to confirm their intention to attend the meeting by the end of January.

The following is the provisional programme:—Monday, September 14th: 3 to 6 p.m., reception and official welcome at the President's House, Webb Institute of Naval Architecture, New York City. Tuesday, September 15th: Morning, meeting to be opened in New York City by the President of the Society; reading of papers (arrangements will be made for entertaining ladies during technical sessions); afternoon, trip around New York Harbour to view the shipyards and other points of interest; evening, banquet. Wednesday, September 16th: Morning, reading of papers; afternoon, visits to the George Washington Bridge, the Holland Tunnel, the Empire State Building, and Radio City. Thursday, September 17th: Trip by steamer to West Point; return to New York; leave midnight by train for Washington, D.C. Friday, September 18th: Sight-seeing at Washington, D.C.; visit to the Washington Model Basin; visit to Mount Vernon and Arlington; evening, leave Washington, D.C., by boat for Old Point Comfort, Va., or remain in Washington as an optional event. Saturday, September 19th: Visit to the shipyard, Newport News Shipbuilding and Dry Dock Company; the Mariners' Museum; Langley Field, Williamsburg; Jamestown and Yorktown; evening, return to New York by train *vid* Washington, D.C., where those who elect to remain there, in lieu of the Virginia trip, will join the main party. Sunday, September 20th: Arrive back in New York.

A STATE petroleum refinery is to be erected by the Iraq Government at Baghdad, and it is reported that experts from the United States are to be appointed to supervise the construction.

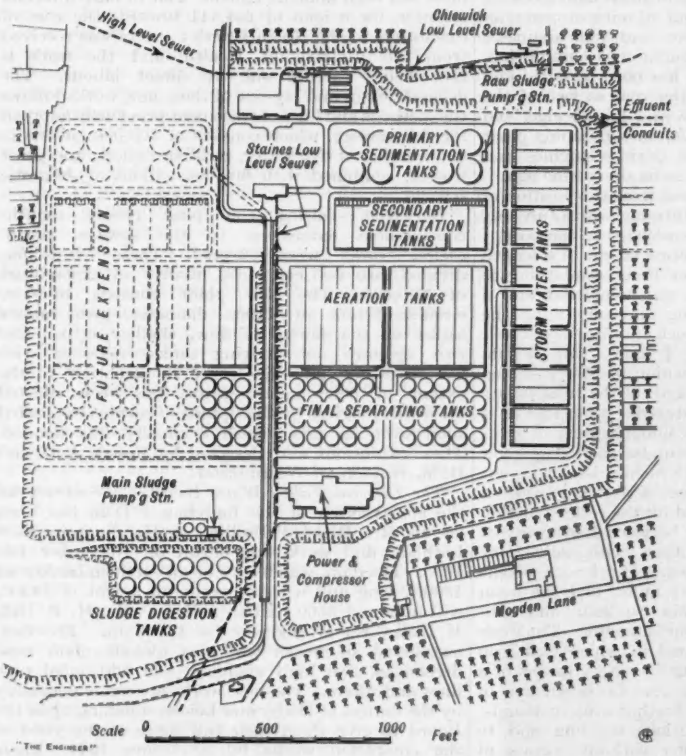
Water Supply & Sanitary Engineering in 1935

No. I.

WITH returning prosperity and the reopening of Government coffers for the help of local governing bodies, the year 1935 was a much more active one from the point of view of water supply and sewage engineers, and several large schemes were authorised, started, or completed. The special measures undertaken to combat drought, combined with the plentiful summer and autumnal rains—the rainfall in November went near to creating a record in the London area—has ensured that the summer of 1936, even though it should prove dry, will see much less hardship suffered by rural communities, while in urban districts generally there is little likelihood of scarcity, since reservoirs have been amply filled. As Mr. John Glasspool pointed out in an interesting statistical paper before the Institution of Water Engineers early in December, the drought was not unprecedented and was comparable with earlier droughts. He was of the opinion that the amounts of rainfall recorded might have been accurately judged from the rainfall records of the last seventy years and justified the statement by the fact that in those districts where it was possible to take earlier records and the experience of previous droughts into account, there was in general no lack of sufficient supplies. Nevertheless, the incidence of the abnormally dry winter half-year of 1933–34 immediately following upon the dry summer of 1933, did give rise to unprecedented rainfall figures for the twelve months ended March, 1934. The summer rainfall of the past year, however, exceeded the average by about 2in. over the country generally, and was accompanied by a curious alternation of dry and wet months. The difficulties of certain communities during the drought give rise to the question whether it might not be preferable to use underground rather than surface water supplies, as they would be less effected by drought conditions. In the opinion of Mr. S. Vere Pearson, it seems probable that the amount of the deeper waters is ample for everyone's use, and more attention would be given to this source if populations were not so unevenly distributed as to require that the supply of large cities should be brought from a distance.

The year 1935 was especially notable for the completion of several big sewage schemes and for the publication of an authoritative report on Greater London Drainage. The latter work examined two proposals, one for the discharge of all the untreated sewage at Dungeness on the south coast, and the other for the treatment of the sewage in about ten works in the London area, and its discharge into the Thames. The expense of the first-mentioned scheme is very great, and certain other strong arguments have been advanced against it. But opinion generally is undoubtedly attracted by the rationality of concentrating the treatment of all London's sewage into a few large works rather than in an admittedly unduly large number of small ones. The expenditure upon the conversion is, however, very much greater than has previously been contemplated in connection with the sewage disposal of the city and the plan merits the careful consideration of all those interested. It may well be that the advantages to be gained are not sufficiently weighty to merit the expenditure, as a first instalment only, of twenty-eight millions of pounds. Meanwhile an advance is already being made in the direction envisaged by the compilers of the report by the construction of the West Middlesex sewage works and the extensions to the West Kent works, both of which were described in our pages during the past year.

The Bill for the construction of the West Middlesex works received the Royal Assent in June, 1931, and the first stage works were completed in October last. The new sewage works, together with its associated sewerage, takes the place of twenty-eight works previously existing in an area of 160 square miles of the county of Middlesex, west of the watershed line passing through Finchley and Chipping Barnet. The population of the area has grown from 493,130 in 1921 and 771,263 in 1931 to about 1,000,000 at the present day, and is estimated ultimately to reach 2,000,000. Sewerage for the scheme has been constructed to meet the needs of the ultimate population, but the purification works situated at Mogden are being built in stages. Already it has been found necessary to start work on an extension which will give the plant capacity to deal with the sewage from a population of 1,250,000, instead of the 750,000 envisaged for the first stage works alone, and the cost when this extension work has been completed will have been in the neighbourhood of £7,000,000. The site at Mogden covers 150 acres, of which about 70 acres will be needed for the construction of purification works sufficient for the ultimate population. The arrangement of the plant is shown in an accompanying engraving, reproduced from an article descriptive of the scheme which we published in our issue of September 27th, 1935. The activated sludge system of purification has been adopted, and the purified effluent is diffused into the Thames. A capacity to deal fully with three times the dry-weather flow is provided, and partial treatment by sedimentation is given to storm water. After preliminary digestion at Mogden the sludge is pumped 7 miles to Perry Oaks for further digestion and for laying out upon drying beds. Gas generated in the sludge digestion tanks is used in gas engines for the generation of electric power and lighting, and the operation of the activated sludge aerating tanks. Messrs. J. D. and D. M. Watson, of Westminster, are the consulting engineers to this scheme.



ARRANGEMENT OF MOGDEN WORKS OF WEST MIDDLESEX SCHEME

Another plant which we described at some length during the year was that installed at Davyhulme, Manchester, which is illustrated by an aerial view on this page. It is designed to deal with a dry-weather flow of over 16 million gallons a day, and is likely to become especially interesting in that three systems of activated sludge treatment are being operated side by side. The largest and most important section, to deal with 16 million gallons a day, treats the sludge by the diffused air method, and was built to the designs of Activated Sludge, Ltd. But there is a one million gallon per day Simplex plant and a 600,000 gallons per day bio-aeration plant. A particularly interesting feature of these works is the compressor plant supplied by Reavells, Ltd., of Ipswich, for supplying the necessary air to the air diffusion tanks. The compressors show particularly high efficiencies.

In what follows we give a summary of reports we have received of progress of work on water supply and sanitary engineering during the year from various quarters.

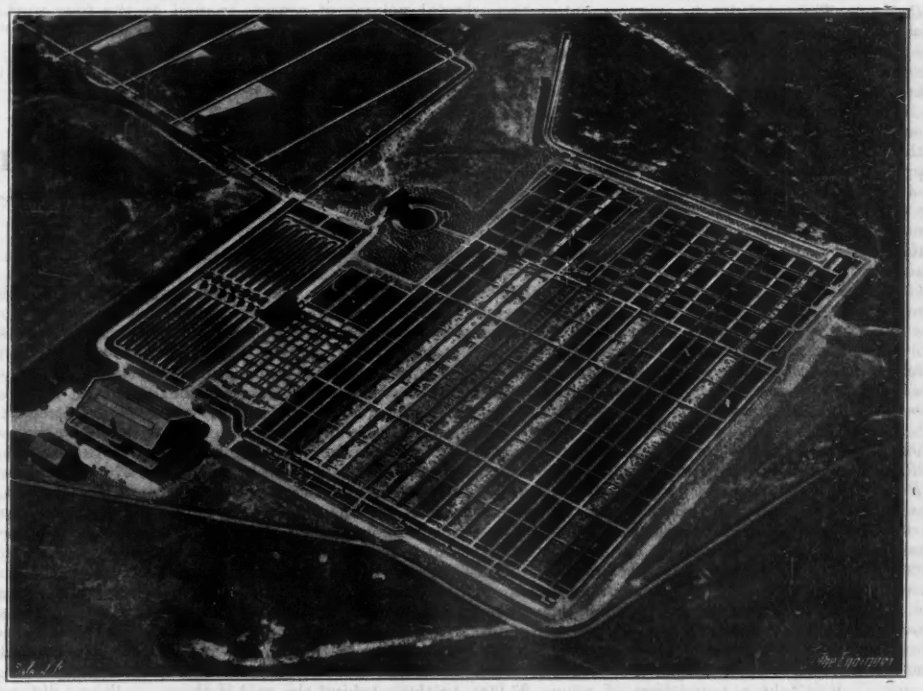
Metropolitan Water Board.

By the courtesy of Mr. J. R. Davidson, Chief Engineer, the Metropolitan Water Board, we are enabled to publish the following details of work carried out in the London area.

Several works referred to in THE ENGINEER on January 4th, 1935, were completed during 1935. The new electrical machinery at Rye Common was set to work in August, 1935. The additional oil engine-driven centifugal pumps installed in an extension of the existing engine-house at Fortis Green were brought into use in May, 1935. The permanent plant which replaces temporary buildings and machinery at Sundridge started work in July, 1935. The construction of primary filtration plant at Green Lanes works is now practically completed and the plant will be brought into use early in the present year.

Hammersmith.—The replacement of some of the older units at this pumping station is in hand. An extension of the engine and boiler-houses has been completed by F. R. Hipperson and Son, Ltd., and the installation of the new pumping plant is about to begin. This will consist of two additional water-tube boilers supplying steam to a turbine driving two centrifugal pumps and a 250-kW electric generator. The pumps will be arranged to work either in series or in parallel delivering 7 million gallons per day, against a head of 300ft., or 10 million gallons per day against a head of 200ft. The electricity generated will drive auxiliary machinery in the works and two units each capable of pumping 2½ million gallons per day against a head of 200ft. The contractors for the machinery are Worthington-Simpson, Ltd., and for the boilers J. Samuel White and Co., Ltd.

Hornsey.—Additional pumping plant is being installed at this station. It is to be housed in a new annexe to the existing engine-house and will consist of two sets of six-cylinder vertical oil engines driving through vee ropes centrifugal pumps, each capable of pumping in series 3 million gallons per day against a head of 300ft. or in parallel 6 million gallons per day against a head of 150ft. The contractors for the



ACTIVATED SLUDGE PLANT AT MANCHESTER

building are G. H. Dibblin, Ltd., and for the machinery W. H. Allen, Sons and Co., Ltd.

Reservoir in the Lee Valley.—A contract for a new storage reservoir in the Lee Valley has been placed with John Mowlem and Co., Ltd., and work has been begun. The reservoir as designed will occupy an area of 386 acres and is situated in the valley through which the river Lee originally flowed. The top water level will be 71·00ft. above O.D. and the water area 334 acres. The length from north to south is 2520 yards, whilst the width varies from a maximum of 980 yards at the northern end to a minimum of 390 at the southern end. The depth of the water when the reservoir is full will vary from 41ft. to 36ft. and its gross capacity will be 3180 million gallons. It will be formed by a continuous earthen embankment, and water-tightness will be secured by a puddle clay core wall in the centre of the embankment carried down and tied into the underlying London clay. The embankment will have a width of 15ft. at the top, an outer slope of 2½ to 1, and an inner slope of 3 to 1. The retaining embankment will contain approximately 3 million cubic yards of material. Various streams and watercourses cross the reservoir site and large volumes of water are carried therein in times of flood. Provision is being made for conveying such flood water past the proposed reservoir. The scheme provides for a new pumping station at the north-eastern corner of the reservoir for lifting the water.

Green Street Green.—An additional bore-hole has been sunk and an oil engine will be installed, driving centrifugal pumps capable of pumping 1 million gallons per twenty-four hours against a head of 360ft.

Sanitary Engineering.

By the courtesy of Mr. J. Peirson Frank, Chief Engineer to the London County Council, we are enabled to give the following details of drainage and flood relief works in the London area. The reorganisation of the Western Pumping Station, Grosvenor-road, Pimlico, where centrifugal pumps, driven by electric power or by oil engines, of a total capacity of 850 tons a minute, are replacing the old beam engines and pumps, is proceeding—see THE ENGINEER, June 28th, 1935. At the Northern Outfall works, Beckton, the construction of aeration channels, settling tanks and re-aeration channels in connection with the extension of the activated sludge plant to treat a total of 60,000,000 gallons of tank effluent a day has been begun, and the installation of sludge digestion plant with a capacity of 200 tons of crude sludge a day is in hand. During the year plants have been installed at both outfalls for the production by chlorination of copperas in solution of ferric liquor for chemical treatment of sewage.

The Brook Green branch of the Hammersmith storm relief sewer, 5ft. 6in. and 6ft. 6in. internal diameter and about one mile in length, driven in tunnel, is approaching completion. The extension of the South-Western storm relief sewer, varying from 4ft. 6in. to 6ft. 6in. internal diameter, of a total length of about 2½ miles, driven in tunnel, proceeded during the year. The construction of two additional spans of the bridge carrying the Northern Outfall sewer over the Waterworks River, necessitated by the widening of the waterway in connection with the river Lee improvement scheme, carried out by the West Ham and River Lee Joint Committee, was completed. In addition to the foregoing, a number of important repair and maintenance works were carried out, as is customary, during the year.

Provincial Works.

Bedford.—The rural district water supply scheme, now under construction, involves the laying of over 150 miles of cast iron mains of from 9in. to 3in. diameter, principally of the latter size, the water being taken in bulk from five authorities, chiefly from the Bedford Corporation and the Biggleswade Water Board. During the year a contract was entered into with the Stanton Ironworks Company, Ltd., for the supply of the pipes, and another contract was made in June last with Squires and Sons, Ltd., of Selby, for the pipe laying. The scheme involves also the construction of a concrete water tower, and a booster station, and an order for the machinery has been placed with W. H. Allen, Sons and Co., Ltd., of Bedford. So far some 45 miles of pipe lines have been completed, and considerable stocks of pipes are on the ground ready for laying. The water tower, which will be 79ft. high, has been carried nearly to its full height, and erection of the steel tank in the upper part is expected to begin shortly. The building of the booster station is proceeding. The engineers for the scheme are Messrs. Binnie, Deacon and Gourley, to whom we are indebted for these details; and the resident engineer is Mr. F. R. Melville, M. Inst. C.E.

Bedworth Urban District Council (Warwickshire).—Sewerage of the Parish of Exhall was in progress during the past year, and the consulting engineers, Messrs. J. D. and D. M. Watson, MM. Inst. C.E., expect the work of the contract to be completed at an early date. The scheme forms an extension to the drainage of the river Sowe Valley, now being provided for by the Coventry Corporation, into whose sewers the flow will be discharged by gravity. The construction of about 8 miles of sewers is involved to serve ultimately a population of about 27,000 persons. The sewers are being laid in concrete, stoneware, and steel tubes in sizes up to 21in. in diameter, and the contractors, Messrs. P. D. Hayes and Son, of Stockport, are employing a considerable amount of local labour on the construction of the works, the estimated cost of which is approximately £25,000.

Belfast.—The principal new water supply works carried out during the past year consisted of duplicating 3½ miles of pipe section of Mourne Conduit with bitumen-protected steel pipes, 38in. external diameter; extending distribution mains, amounting to 22½ miles of cast iron pipes, 4in. to 6in. internal diameter; and laying an 18in. steel connecting main for a distance of 2 miles to link up Mourne and Stonyford supplies. This work included a crossing under the tidal river Lagan for a length of 300ft.

Birmingham.—Steady progress was made with the laying of the third main on the Elan Aqueduct, and when the work now in hand has been completed there will remain approximately 6½ miles to be laid out of a total of 36½ miles of the siphon sections. Within the statutory area about 5¾ miles of concrete-lined steel trunk mains of 60in. and 36in. diameter have been completed and brought into commission. New electrical pumping plant has been installed and was brought into use during the year at two of the standby stations, Short Heath and Longbridge, and at the Whitacre pumping station new pumping plant has been provided to replace Cornish engines and pumps which were dismantled some short time ago.

Sir Herbert Humphries retired from the position of City Engineer and Surveyor of Birmingham in July last, and Mr. Herbert J. Manzani succeeded to the post.

The first contract for the improvement of a length of nearly 2½ miles of the river Rea, terminating at Lawley-street Goods Station, was completed, and a further contract for deepening and improving the river Rea between Lawley-street and Moseley-street, a length of approximately ¾ mile, was begun. The work comprises the deepening of the river bed by an average of 4ft. This length of the river passes through a closely built-up industrial area, and it is necessary to carry out heavy underpinning of river walls, buildings, and bridge foundations. The river bed is being paved with Staffordshire blue wire-cut bricks on a concrete foundation. A contract has been let and the work is well in hand for the reconstruction of the Rea Valley main sewer between Lawley-street and MacDonald-street, together with subsidiary sewers adjoining the river Rea. The length of the sewers in question is about 1¾ miles, and the main sewer varies in size from 75in. to 98in. and subsidiary sewers from 45in. to 60in. diameter. The work included construction in tunnel in which cast iron sections were used, parts being driven by means of a shield. A contract was let for an extension of the Valley sewers to drain a further area of Handsworth Wood to alleviate serious flooding and to provide for built-up portions without means of drainage. The length of sewers in this contract is approximately 2 miles, the sizes varying between 9in. and 39in. diameter. This work is nearing completion. The estimated cost of the work is £20,000. The reconstruction of ½ mile of main sewer in the Saltley-road in order to relieve flooding conditions is being carried out. The new sewer here varies in size from 57in. to 72in. diameter, and the estimated cost is £21,000. Several other smaller sewerage contracts are in hand or complete.

Bradford.—The annual report for the year ending August, 1935, of the city of Bradford Sewage Department is a very interesting document, since at the Esholt disposal works, opened about two years ago, much experimental work is being carried out. The total volume of sewage treated at the four works under the control of the department was 6,931,099,100 gallons, more than 6000 million gallons being treated at Esholt alone. The average daily volume works out at 18,989,312 gallons. In contrast with most sewage works, Bradford is unusual, in that in the process of purification a by-product is recovered. This product is in the form of grease and is considered of very low quality in the oil world, but, nevertheless, it has been a source of revenue. The production, however, is in excess of the demand and various processes for treating the grease with the object of improving its quality and the demand for it are being tried. It will also be remembered that at Esholt there is a sludge press house producing a product of manurial value. In the process an undefinable but definitely unpleasant odour is emitted, and the problem of suppression has been tackled on quite a large scale. The method used is to scrub the gas with a liquor containing about 40 parts per 100,000 of chlorine. Experimental work in this connection is continuing.

As far as actual constructional work is concerned little has been done at Esholt. But in May a formal sanction for a loan of £44,441 towards the cost of extensions to the North Brierley works was received from the Ministry of Health, and the work is now being carried out by direct labour. The general design and lay-out of these new works follows the methods and lines of treatment previously adopted for this sewage, which consists of 700,000 gallons in dry weather of dye water, pickling liquors, and yeast wastes, combined with 600,000 gallons of domestic sewage.

Darlaston.—During the past twelve months considerable extensions to the sewage purification works were effected. These extensions, divided into two contracts, involve an expenditure of £10,000. The new plant consists of two circular filters of 110ft. diameter, two humus tanks of the horizontal-flow, shallow type, and two ejectors for sludging tanks, together with the necessary pipe lines, &c. Reclamation, to the extent of 5000 square yards, has been effected for works progress by the tipping of surplus excavated spoil over an area which originally was flooded. These extensions were designed by Messrs. J. D. and D. M. Watson, of Westminster.

The Derwent Valley Water Board.—A contract for the construction of the Ladybower Dam has been let to Mr. Richard Baillie, of Haddington, East Lothian, and work was begun on November 1st, 1935. The dam, which is to be an earth embankment 1300ft. long and with a maximum height of 143ft., will impound 5500 million gallons. Mr. H. P. Hill, M. Inst. C.E., is engineer for the dam. The final instalment of works will also include main road diversions, two high viaducts, and additional pipe lines and filters. The new works are made necessary by the notices of Derby and Leicester calling upon the Board to give them their full share of the yield of the completed works by or before 1944. Their total cost is estimated at £1,650,000.

Epsom and Ewell.—During the past twelve months extensions to the Ruxley sewage disposal works were completed, together with the major portion of the Ewell and Cuddington main sewer, work now being in hand on the remainder of the sewer. Negotiations are proceeding in connection with the Joint Board constituted by the Urban Districts of Epsom and Ewell, Surbiton, Maldens and Coombe, and the Borough of Kingston, with a view to a joint disposal works at Surbiton. In this respect the Council applied to the Ministry of Health for loan sanction on £68,478, being the estimated cost of sewerage works in the urban district covering relief and intercepting sewers and a trunk sewer, which will connect to a joint sewer through Surbiton.

(To be continued.)

Electrical Engineering in 1935.

No. I.

Introductory.

CONTRARY to what may have appeared probable to those unfamiliar with the fields available for exploration and the many existing establishments, industrial and otherwise, that remain to be electrified, completion of the grid has not left electrical manufacturers in need of work or devoid of a bright outlook. More people were, in fact, employed in electrical manufacture during the twelve months under review than in any other period of its history. During July the number engaged in all branches was 270,970, against 257,830 in the corresponding month of the preceding year. The manufacture of cables, wires, and lamps was responsible for the largest percentage increase, and wiring and contracting work for the second largest. From the latter it is pretty clear that in this country conditions are improving. But seeing that large sums of money have been spent on increasing the availability of electricity and on reducing the cost of generation, that was only to be expected. It would be unfortunate, and truly disappointing to those behind the grid if these conditions did not prevail. Foreign trade, which, after all, is what the country mainly needs, is in a different category, and upward trends in this direction are worthy of a cordial welcome. Over a corresponding period of 1934 exports of electrical goods and apparatus rose in 1935 by over 22 per cent., while imports diminished by 1 per cent. The Government's policy of financing large-scale public works is encouraging, so far as home business is concerned.

Of orders received for generating plant during 1935, that for a 75,000-kW turbo-alternator was the largest. Another was for a 50,000-kW set. Others were placed for machines with outputs in the region of 30,000 kW. Generating plant of considerable capacity was shipped to the Colonies. But the largest contracts awarded were for electric railway equipment to meet the requirements of various British schemes, including those of the Southern Railway, the London Passenger Transport Board, the L.M.S., and the L.N.E.R. Large contracts of the kind were also secured in South Africa and Brazil. Although in this country universal electrification is not viewed by railway people in the light electrical engineers desire, manufacturers have no real grounds for complaint. The orders they are receiving, though no

doubt of much less value than those they seek, are far from insignificant, and seeing that, unlike other countries that have adopted electrification on an extensive scale, this country does not possess abundant water power, the call for electric traction equipment, both for railways and road services, is not to be regarded as unsatisfactory. The electric trollybus business is making very rapid strides.

The Central Electricity Board.

With the exception of the comparatively small area of South Scotland and the area embraced by the North-East England scheme, in which frequency standardisation is still in progress, the Central Electricity Board is now engaged in general trading throughout the whole country covered by the grid. Early in February the Royal Assent was given to an Act which empowers the Board to enter into arrangements with authorised undertakers who own or control non-selected stations, with a view to working them in conjunction with the grid. Several such arrangements, believed to be beneficial to all concerned, were completed. At the beginning of September, for example, agreements were reached between the Board, the Birkenhead Corporation, and Lever Brothers. Under these agreements the private generating plant maintained by the latter at Port Sunlight is to be operated in conjunction with the Birkenhead station and under the control of the Board. All requirements of Port Sunlight, amounting to nearly 40,000,000 units a year, will thus in future be supplied from the grid.

By the installation of new plant in existing stations, the aggregate capacity of selected stations was increased. The 105,000-kW set illustrated in one of our Supplements was installed in the Battersea station of the London Power Company. Built by the Metropolitan-Vickers Electrical Company, the turbine has three cylinders. It is the largest unit in Europe. Steam conditions are 570 lb.–600 lb. per square inch gauge and a temperature of 800–850 deg. Fah. The speed is 1500 r.p.m. The only large and important steam station put into service was the Tir John station of the Swansea Corporation, also illustrated in one of our Supplements. The first two hydro-electric stations of the Galloway Power Company at Tongland and Glenlee in South Scotland were put into service. Other new stations of comparatively small output were brought into use by the Dolgelley Urban District Council, the Campbeltown and Mid-Argyll Electric Supply Company, Ltd., the Todcaster Electric Supply Company, Ltd., the Towyn, Aberdovey and District Electric Supply Company Ltd., and the Yale Electric Power Company, Ltd. The new Fulham station, illustrated in its present stage of construction in the Supplement mentioned, should be running about next June. Three stations belonging to public authorities and ten owned by companies were shut down. With the approval of the Electricity Commissioners, the Board issued instructions for extensions to selected stations, representing in all 700,000 kilowatts of generating plant and boilers with an aggregate capacity of approximately 7,000,000 lb. per hour.

Construction of the Colchester, Clacton-on-Sea, Frinton, Harwich and Colchester secondary line was completed, and all sections brought into service; and the new secondary line from Three Bridges to East Grinstead, where there is a new sub-station, was also completed. For giving supplies to the Southern Railway at Eastbourne and Hastings, sub-stations were opened in the early part of the year. Other sub-stations were put into service at Glenlee, Oxford, Newton Abbot, and Exeter. To give new supplies to authorised undertakers in various parts of the country, additional equipment was installed at a number of grid points. The route was surveyed for a new line between Egremount and Carlisle to reinforce the existing line between those points. In the three areas in which the work of standardising frequency is in progress, namely, North-East England, Central England, and South Wales, large blocks of plant were converted to the standard frequency.

Generating Sets.

Apart from having acquired the distinction of putting into operation at the Battersea station of the London Power Company the largest turbo-generating set in Europe—the 105,000-kW machine illustrated elsewhere—the Metropolitan-Vickers Electrical Company, Ltd., established something in the nature of another record by installing in Moscow a 24,000-kW, 3000 r.p.m. primary turbine designed to operate at 1763 lb. per square inch and at a maximum temperature of 932 deg. Fah. Several Metrovick sets of 30,000 kW and over were put in hand. The largest to be installed in the Barton B station of the Manchester Corporation is to develop 51,500 kW at 33,000 volts, made possible by a special type of winding claimed to have an unusually high factor of safety. Three additional 33,000-kW, 3090 r.p.m. Metrovick two-cylinder sets, corresponding to those ordered in 1934, are being supplied to the Victoria Falls and Transvaal Power Company, together with a second 7000-kW house service set. But more interesting from the point of view of steam conditions and voltage is a 20,000-kW, 3000 r.p.m. set for installation in the reconstructed Brimsdown A station of the North Metropolitan Electric Power Company. This two-cylinder turbine is to use steam at 1900 lb. square inch gauge superheated to 930 deg. Fah. It will exhaust at 200 lb. pressure, which is the existing boiler pressure at which a new 34,000-kW Metrovick condensing turbine is to operate. The alternators of both these new sets are to be wound for 33,000 volts, a pressure which, since the first Parsons 33,000-volt machine was put into service at Brimsdown, is now often called for.

Despite the tendency for industrial concerns to purchase electricity rather than generate it, there seems to be a fair demand for small sets, although most of them are apparently built for places abroad. Self-contained geared turbine sets ordered from the Metropolitan-Vickers Electrical Company ranged from 200 to 6000 kW. One of the latter capacity is being supplied to the Poplar Borough Council, and a 4000-kW machine is being built for the Workington Iron and Steel Company, Ltd. Pass-out and back-pressure units were also built, but we must turn now to some of the more important work of other firms.

The two 51,000-kW turbines under construction at the Heaton Works of C. A. Parsons and Co. for the Hams Hall power station are nearly completed. The pair of 30,000-kW, 36,000-volt machines for the Tir John station, Swansea, were put into commission early in the year, although the station was not officially opened until June. Other high-voltage sets put into commission were the third 20,000-kW, 36,000-volt set for the Salt River station at Cape Town, and the 20,000-kW, 22,000-volt unit for the East Rand station. Work on the 30,000-kW, 36,000-volt set for the Northampton station was completed, and the machine passed the shop tests. An order was received for a 25,000-kW, 36,000-volt alternator to replace a low-voltage machine in the Upper Boat station of the South Wales Power Company, which has had one of these high-pressure machines in service since 1933. With the machines under construction there will soon be eleven Parsons high-voltage concentric conductor alternators at work with a total capacity of 330,000 kVA.

Of the Parsons sets built for ordinary voltages a 25,000-kW set put into service at the Kingston-upon-Hull municipal power station is one of the most interesting. It is shown beneath the view of the interior of the Tir John station in our Supplement, and is noteworthy by reason of the large output developed in a single cylinder at a speed of 3000 r.p.m. The turbine is a single-flow, duplex-exhaust machine. It takes steam at 375 lb. per square inch superheated to 775 deg. Fah. and exhausts into a vacuum of 28·5in. A unit built for the same speed and output is being erected at the Southampton power station, which is to have another Parsons machine corresponding so far as speed and output are concerned. A two-cylinder tandem unit to develop 25,000 kW at 2400 r.p.m., with steam at 600 lb. superheated to 800 deg. Fah., is being built for the Government of Western Australia. The same output at 3000 r.p.m. will be provided by a machine to be reconstructed for the North Tees B station in which the frequency is being raised from 40 to 50 cycles. A corresponding change is being made in the Carville B power station, and the last of the old machines is being reconstructed by C. A. Parsons and Co., Ltd., to give 12,500 kW at the higher speed of 3000 r.p.m. When the work is completed the station will contain 65,000 kW of plant modernised by the firm that built it.

Amongst the overseas orders was one for a 12,500-kW turbo-generator set for the City of Port Elizabeth, South Africa, and another for a 15,000-kW machine for the Wellington City Corporation, New Zealand, where it will serve as a standby to hydro-electric plant. An industrial set of the same capacity and speed was put into service at the Runcorn Works of Imperial Chemical Industries, Ltd., in which the steam conditions are 600 lb. and 800 deg. Fah. Orders for both power station and industrial turbo-generating sets came from Australia, Canada, China, India, South Africa, and New Zealand. Fourteen machines are being supplied to these countries. Most of them drive turbo-alternators direct or through gearing, but two geared turbines of 4310 and 3840 b.h.p. will drive centrifugal pumps belonging to the Rand Water Board.

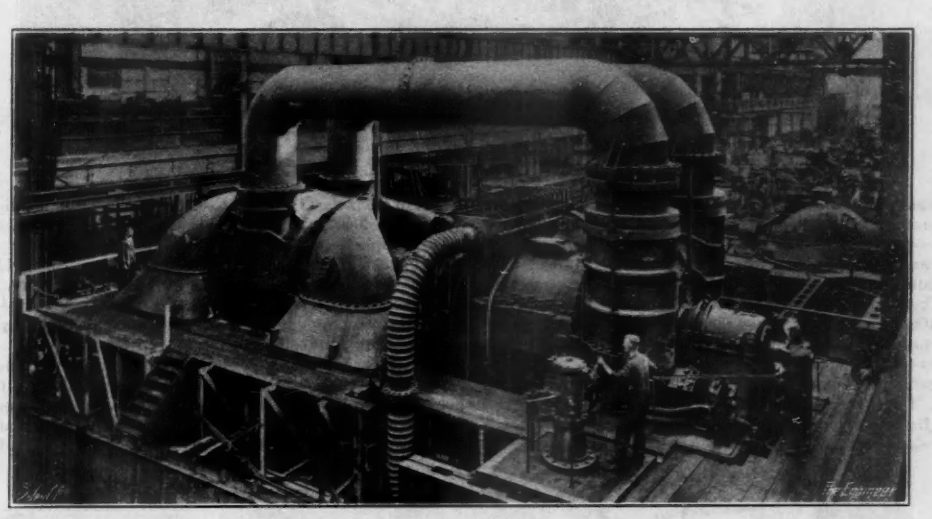
Perhaps the most notable B.T.H. machine completed was the two-cylinder, 50,000-kW, 33,000-volt turbo-alternator for the Ironbridge station of the West Midlands Joint Electricity Authority, illustrated herewith. The steam conditions are 375 lb., 750 deg. Fah., and 28·9in. vacuum. Two 30,000-kW two-cylinder turbo-alternators designed for 600 lb. pressure and a total temperature of 825 deg. Fah. were built. One is for the Neepsend generating station of the Sheffield Corporation, and the other for the North Wilford station of the Nottingham Corporation. For the Spandon station of the Derby and Notts. Electric Power Company the firm also completed a 3000 r.p.m. turbo-alternator designed for 350 lb. per square inch and 685 deg. Fah. There is in course of manufacture in the Rugby works a two-cylinder 51,600-kW machine for the Kearsley power station of the Lancashire Electric Power Company. It is to run at 1500 r.p.m. and will be supplied with steam at 600 lb. per square inch and a total temperature of 800 deg. Fah. A third B.T.H. 75,000-kW turbo-alternator is in the course of manufacture for the Barking power station of the County of London Electric Supply Company, Ltd.

Steady progress was made by the English Electric Company in the manufacture and installation of the hydraulic-electric plant for the second stage of the Galloway Water Power Company's hydro-electric scheme, comprising the Kendoon, Carsfad, and Earlstown power stations. The Tongland and Glenlee stations for the first stage of the scheme were put into operation early in 1935. Three horizontal shaft overhung reaction water turbines are being built for the India Stores Department, each to give 18,000 h.p. under a maximum head of 160ft. Other hydro-electric machines on order are two reaction turbines and alternators for the Upper Watut Gold Alluvials, New Guinea, and an 840-kVA water wheel-driven alternator for the North Wales Power Company. Orders for steam turbo-alternator sets from 30,000 kW downwards are being dealt with.

English Electric oil engine generating sets appear to have been in considerable demand. Amongst the outstanding orders was one from the Air Ministry for four 875 h.p. oil engines, together with alternators and switchgear. To the Admiralty the company is supplying seven oil engines with an aggregate capacity of 8500 h.p. Other oil engine sets are for South Africa, the Gold Coast, Malay States, India, the War Office, Australia, Christmas Island, and England. For meeting the light and power requirements of the British Pavilion at the Universal and International Exhibition, Brussels, the company supplied the oil engine generating plant shown on page 28. The plant, which consists of two 300 h.p. oil engines, each coupled to a 200-kW alternator, formed an exhibit and was awarded the Grand Prix.

The largest generating machines under construction in the Witton works of the G.E.C. are the 62,500-kVA alternators to be coupled to the new turbines in the Hams Hall power station, Birmingham. Other large machines are being built for Palestine, Johannesburg, and other parts. The demand for smaller machines exceeded all previous records and Australia, India, China, South America, Singapore, New Zealand, West Indies, West Africa, Persia, Egypt, and Madeira are among the places to which they have been or are about to be supplied.

The 30,000-kW Ljungström turbo-generator set at present under construction at the Brush Electrical Engineering Company's works for Brighton will be



50,000 KW TURBO-ALTERNATOR FOR IRONBRIDGE

the largest machine of the kind so far constructed in this country.

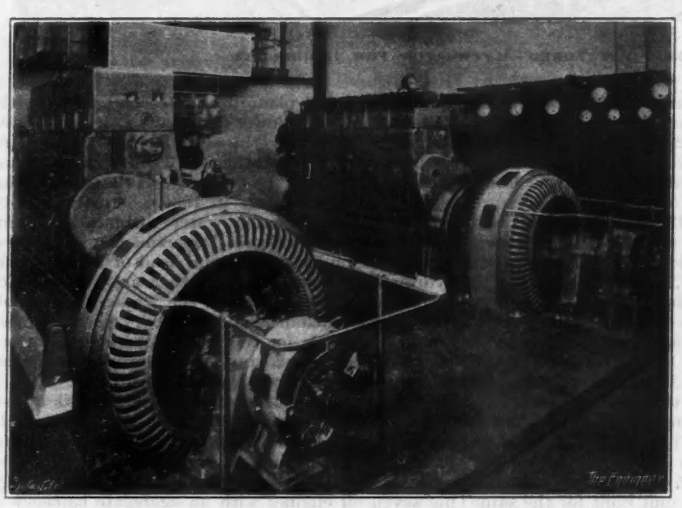
Industrial Electrification.

Frequency changes from 25 and 40 cycles to 50 cycles continued to provide electrical manufacturers with a large amount of work. Steps were taken in some cases to raise the power factor in conjunction with the change, as exemplified by the Birchley rolling mills, at which four B.T.H. motors driving mills without fly-wheels, and consequently having a very large overload capacity, originally worked at low power factor. But by providing each mill motor with a shunt phase advancer, the power factor has been raised at all loads, except excessive overloads, to unity. The benefits some firms are still deriving from the frequency-changing programme can be gauged from two jobs undertaken by the Metropolitan-Vickers Electrical Company. In one case, thirty-one haulage motors ranging from 200 to 400 h.p. and totalling 8000 h.p. were supplied; in the other case, the job involved the supply of forty-five motors, ranging from 150 to 350 h.p., and aggregating 10,700 h.p.

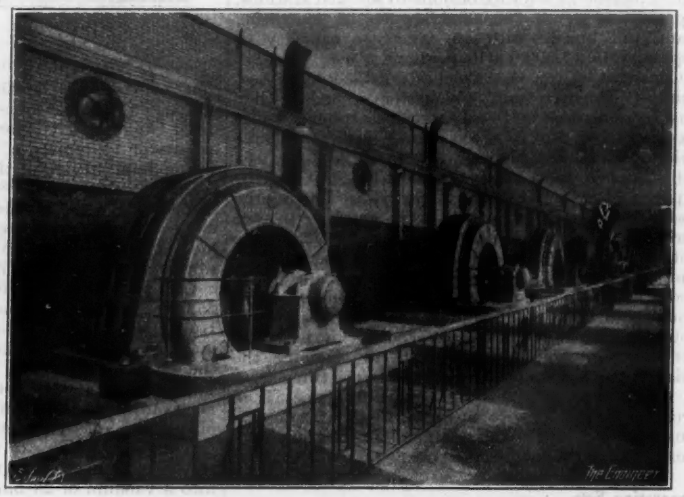
But reverting to rolling mill drives, business in this direction seems to have been fairly brisk. To take some of the more important jobs, a complete order was placed with the Metrovick company for a 2900 h.p. motor with a peak load capacity of 9070 h.p., supplied by a steam turbine driven fly-wheel generator set, with provision for the addition of another generator and turbine to supply another mill motor. As the order for the extension was placed early in 1935, the whole equipment went through the factory at the same time. The equipment, which is said to be the only one of the kind in this country, comprises two 2900–9070 h.p. D.C. reversing mill motors and the fly-wheel generator set—illustrated—comprising two main generators, two auxiliary generators, and a 28-ton fly-wheel, all driven by two 4200 h.p. steam turbines at opposite ends of the set. To John Lysaght and Co., Australia, and Colvilles, Ltd., of Motherwell, mill motors were also supplied and various mills, including those of the Park Gate Iron and Steel Company, of Sheffield, were changed over from engine to electric drive. A special high-torque induction motor was developed by the Metrovick company for the severe duty imposed by live rollers.

FLY-WHEEL GENERATOR SET FOR STEELWORKS

Schemes for the reorganisation of the iron and steel industry created a demand for large G.E.C. electric rolling mill equipments. For Guest, Keen, Baldwins Iron and Steel Company, Ltd., and Dorman, Long and Co., Ltd., G.E.C. electric motors for rough-



OIL ENGINE GENERATORS AT THE BRUSSELS EXHIBITION



2500 H.P. SLIP-RING INDUCTION MOTORS

electric driving equipment is being manufactured by the Metropolitan-Vickers Electrical Company for the Whitehead Iron and Steel Company, for a four-high reversing cold strip mill, said to be the first mill of the kind to be installed in this country. The electrical equipment consists of a 375 h.p., 500–800 r.p.m. reversing motor driving the mill itself, and two 300–1200 reversing motors driving the reels—all supplied from a 500 h.p. synchronous motor generator set operating on the Ward Leonard system of control. The drive presents many peculiar and interesting problems, which, unfortunately, cannot be considered here. Other Metrovick rolling mill contracts included driving plant for a small push bench equipment for installation at Shanghai, to the order of the Wellman Seaver Rolling Mill Company, Ltd., and the reconstruction of the rod mill at the works of the Templeborough Rolling Mill Company. An equipment at present being erected on site is a large reversing mill at the Briton Ferry Steel Works Company, South Wales. In 1934 an ing and finishing mills are in course of manufacture. Two electric rolling mill equipments were completed, one for Arthur Lee and Sons, of Sheffield, which included four large motors with a total capacity of approximately 4000 h.p., and the other for the Pirelli-General Cable Works at Eastleigh.

Many large steel works drives are reported to have been put into service by the English Electric Company, which is constructing two equipments of 17,000 h.p. (peak) and 20,000 h.p. (peak) for South Africa and South Wales respectively, both operating on the Ward Leonard and Ilgner systems. Amongst the B.T.H. rolling mill drives are a 500 h.p., 100–190 r.p.m. D.C. motor with a rotary converter to drive a 12in. strip mill; an 800 h.p., 585 r.p.m. induction motor with auxiliary motors and control gear, driving an 18in. bar mill; and a 750 h.p., 494 r.p.m. induction motor and control gear for driving a sheet mill rolling "Staybright" steel in the works of Firth-Vickers Stainless Steel, Ltd.

The electric winder business appears to have shown marked improvement compared with that of the previous year. For South Africa the B.T.H. Company completed several important equipments, including two said to be among the largest in the world, namely, a 4150 h.p. rock hoist and a 2440 h.p. man hoist. Both are for the Grootvlei Proprietary Mines, Ltd., and are for winding to a depth of 5000ft. A 1424 h.p. B.T.H. set is being supplied to the Crown Mines, Ltd.; two 2876 h.p. winders for East Rand Proprietary Mines, Ltd.; and a 1850 rock hoist and a 1700 h.p. main hoist for Van Dyk Consolidated Mines, Ltd. Among the equipments under construction are a 320 h.p. Ward Leonard Ilgner equipment for Blackwater Mines, Ltd., New Zealand, and two 1100 h.p. geared A.C. winders and a Ward Leonard 932 h.p. equipment for East Rand Proprietary Mines, Ltd.

A continuous demand from South Africa for mining plant was experienced by the General Electric Company, which has a considerable amount of electric winding equipment in the course of construction. Equipment is being installed in one of the mines at a depth of 7000ft., and to reduce noise the high-speed induction motor of the Ward Leonard motor generator has purely axial ventilation. Winding equipment for the mines of the International Nickel Company of Canada consists of three 1200 h.p. D.C. motors. One drives a cage hoist and the other two are coupled in tandem to form a 2400 h.p. unit for driving a rock hoist. For both winders Ward Leonard motor generators with synchronous motors are employed, and in the case of the rock hoist the synchronous motor drives two generators, one for each of the driving motors.

Space limitations naturally preclude the possibility of touching upon anything beyond the fringe of industrial electrification. There was substantial progress in many directions, such as in paper and rubber mills and in engineering works. A greatly increased demand was experienced for electrical equipment for the machine tool industry, which has called for many frequency-changing sets for the operation of high-speed tools. As regards paper mills, at the Kemsley mill of Edward Lloyd, Ltd., the A.C. sectional drive was applied by the B.T.H. Company to a newsprint machine, said to be the largest in the world. Designed for a maximum paper speed of 1440ft. per minute, the A.C. commutator motors driving it have an aggregate horse-power of over 2000. Another noteworthy B.T.H. sectional drive installed operates on the "synchronous tie-in" system, which is new in this country. The paper machine, which is 134in. wide, is driven in nine sections, and has a paper speed range of 45ft. to 600ft. per minute. A B.T.H. D.C. motor supplied from the mill system in series with a common reversible booster drives each section. Armature voltage variation provides the lower part of the speed range, whilst the higher speeds are obtained by field weakening. A low-voltage generator coupled to the booster, from which the sectional motors are supplied, gives inching and steady running creeping speeds. Seven slip-ring induction motors installed in the Kemsley mills of Edward Lloyd, Ltd., for process work are illustrated. These are G.E.C. motors and each is rated at 2500 h.p. at 250 volts, and is wound for 6600 volts.

(To be continued.)

"HEAT TREATMENT OF STEEL."—This is the title of publication No. 6 of the "Industrial Uses of Gas" series of brochures being issued by the British Commercial Gas Association, 28, Grosvenor-gardens, S.W.1. It contains concise explanations of the theory of the various processes of heat treatment and the requirements of each class of work. The design of gas furnaces, the types of work for which they are suitable, and a number of typical installations are illustrated. The book, which is issued free of charge, will be interesting and useful to those concerned with heat treatment.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

British Steel Duties.

The only development of interest regarding the iron and steel industry over the Christmas holiday period has been the announcement by the Treasury that on the recommendation of the Import Duties Advisory Committee the present duties of 20 per cent. upon imported iron and steel will be continued unaltered. Following the agreement between the British Iron and Steel Federation and the European Steel Cartel in July of last year the duties which had been raised to a figure which practically prohibited the importation of Continental steel material were reduced to 20 per cent. *ad valorem*. This reduction was limited to a period of five months ending on January 7th, 1936, pending a decision as to the precise method of dealing with imports as a result of the arrangement. Since July discussions have been taking place between representatives of the British and Continental steel makers upon the subject. The last meeting was held at the beginning of December, when the British proposals were laid before the Continental steel makers, and the latter agreed to consider these proposals and to make their views known at a meeting to be held early in January. The British are pressing their plan which provides for a system of licensing and the purchase by the newly formed British Iron and Steel Corporation of all imports of Continental steel *en bloc*, and their resale to the Continental selling organisations in London. Their distribution would then be supervised by Committees representing the selling organisations and the British steel makers. According to report, this plan is by no means popular on the Continent, and is regarded with hostility by some sections of the trade in this country. It is significant, however, that in the announcement that the present duty of 20 per cent. is to be continued, it is pointed out that the matter of handling the imports is still being considered, and that whilst the reduction in the duty is continued without definite time limit it is subject to review in due course. This is generally regarded as being a threat to bring into operation higher duties if the Continent does not agree to the British demands. The Treasury has also taken a step on the recommendation of the Import Duties Advisory Committee which has been overdue for some time. Since the issue of the first Additional Duties Order in 1932, about one hundred further orders have been issued, and it has been decided to consolidate the tariff of duties and to make such rearrangement as in the light of experience appeared likely to improve its form and order. The changes are embodied in the Import Duties (General) Order, 1935; the Import Duties (Exemptions) (No. 15) Order, 1935, and the Import Duties (Exemptions Consolidation) Order, 1935.

The Pig Iron Market.

Little inclination has been shown this week to discuss fresh business and holiday influences have been apparent in all departments of the market. The suspension of deliveries over the break resulted in an increase in the stocks in the makers' yards, but this was welcomed by the producers, as specifications for January delivery have been reaching the works already in considerable volume, and the production in more than one district in this country has fallen behind consumption. The uncertainty of the price position as a result of the miners' demands for higher wages has made forward business practically impossible. It is understood also that the prices of foundry iron will be reviewed early in the New Year and the market anticipates further advances to cover the probable increase in production costs. On the North-East Coast the stringent conditions which have ruled for some months seem likely to be continued well into the New Year, as although there have been rumours that new furnaces will be put into operation no steps seem to have been taken in this direction. The shortage of Cleveland foundry iron is so pronounced that a fair tonnage of Midland irons is being used by consumers on the North-East Coast to make up for the deficiency. In the Midlands deliveries to consumers were resumed as soon as possible after the holiday stoppage. The demand for practically all classes of iron has been exceptionally strong for the time of year; but a comparatively small amount of fresh business has been transacted, as the producers are reluctant to enter into important engagements until they have a better idea of the way in which the coal trouble will develop. The general view is, however, that further price advances will not be long delayed. Most consumers are well covered for the first few months of 1936, but many of them would like to place further forward contracts, so that the New Year is opening under favourable conditions for the makers. In the Lancashire market business has been confined principally to the discussion of future commitments when the situation is clearer. Most consumers are well covered, but owing to the quiet conditions ruling in the textile machinery industry the scarcity of foundry iron which prevails in some other districts is not so noticeable here. In Scotland deliveries were made right up to commencement of the holidays, and will be resumed directly the New Year break is over. The situation in the hematite market is particularly favourable to the producers. Consumers are covered for some time to come and deliveries against contracts are being made on a heavy scale.

Scotland and the North.

At the end of the year all the Scottish iron and steel industries are in an excellent position as regards the orders on their books and the promise of work to come. The outlook, however, is somewhat marred by the uncertainty felt regarding the coal situation and the possibility of price changes. Fresh orders for ships continue to reach the Clyde yards, and this industry in Scotland is busier than it has been for some years. Specifications for material required in the construction of vessels recently ordered are coming to hand regularly and a heavy tonnage of plates and sections is being absorbed in this way. Although the plate mills are not employed to capacity, the amount of business which has reached them of late has shown a considerable expansion on recent months. The demand for boiler plates in particular, which had been slack for a long time past, has been improved by recent home and foreign railway orders. Business in sheets has expanded of late, particularly upon home account, and the works in Scotland have booked good tonnages. The increase of 5s. in the prices of black and galvanised sheets, which raised the price of 12-G. black to £9 15s., 13-G. to £10 2s. 6d., and 14 to 16-G. to £10 15s. d/d has not affected business. These quotations are for open annealed material, and an extra of 10s. is charged for close annealed sheets. Sheets under $\frac{1}{8}$in. to $\frac{1}{4}$in. have also been brought under control and the price fixed at £9 5s. Thus all sheets are now controlled. Business in galvanised sheets continues rather scarce for home and export. In Lancashire a general disposition was noticeable before Christmas to postpone fresh purchases until the New Year. The majority of consumers have been careful to cover their requirements as far forward as possible, and some of the constructional engineers are reported to have bought for at least six months ahead. Deliveries, of course, practically ceased since the end of last week and are not likely to be resumed on a pre-holiday scale until early in January. In the lighter departments of the trade rather exceptionally busy conditions have ruled, and there has been a good demand for special steels. Business in bright steel bars, which fell off for a time, experienced something in the nature of a revival at the close of the year. On the North-West Coast the works are well occupied and a considerable tonnage of rails, billets, bars, and slabs is being produced. Some good contracts for rails are in hand for the home railways, and lately the makers have experienced a strong demand for hoops and merchant bars. Business in spring steel also has been of a satisfactory character for the past few weeks.

Current Business.

The English Steel Corporation has decided to re-open the works of its subsidiary company, the Darlington Forge, Ltd. A start will be made in the New Year upon the work necessary to bring the plant and equipment to a state of efficiency equal to the Corporation's Sheffield works. The Darlington Forge in the past has made stern frames and castings for many famous liners. The London and North-Eastern Railway Company has placed orders for ten locomotives with Sir W. G. Armstrong, Whitworth and Co., Ltd., Newcastle-on-Tyne; sixteen vestibuled open third-class carriages with the Metropolitan-Cammell Carriage and Wagon Company, Ltd., Birmingham; and eight similar vehicles with the Birmingham Railway Carriage and Wagon Company, Ltd., Smethurst. This is the first instalment of the work to be carried out under the Government guaranteed loan authorised by the Railways (Agreement) Act. Harland and Wolff, Ltd., Belfast, have received an order from the Union Castle Mail Steamship Company, Ltd., for a small cargo vessel. The exclusive rights in this country to manufacture hot strip metal under the Armco patents owned by the American Rolling Mills Company, Middletown, Ohio, U.S.A., have been secured by Richard Thomas and Co., Ltd. The patents are claimed to cover the most modern methods of producing steel sheets up to 18-G. for subsequent conversion either by hot or cold reduction mills into motor car body sheets and tin-plates. The London and North-Eastern Railway Company is providing four grabs at the Immingham Dock for the unloading of ore from ships. These are in addition to two 30-cwt. grabs provided a short time ago and will enable unloading to take place simultaneously from all holds of the steamer at one berth and at the same time for discharge to take place through the largest holds of another steamer at an adjacent berth. Carron Company proposes to extend its Mungal Foundry at Carron, Falkirk. Plans include the extension of the structural fittings shop and the existing warehouse building. The Department of Overseas Trade announces that the following contracts are open for tender:—South African Railways and Harbours: two 25-ton capacity overhead electric travelling cranes (Johannesburg, January 27th); one 10-ton overhead electric travelling crane (Johannesburg, February 3rd); Johannesburg City Council: 1000 gas meters, 125 cubic feet high capacity (Johannesburg, January 25th); Singapore Municipal Water Department: supply of sluice valves for water (London or Singapore, March 9th).

Copper and Tin.

No particular feature of interest has developed in the electrolytic copper market over the holidays. Many consumers, of course, are stocktaking and although there has been a fair volume of inquiry from Italy since business was resumed, trading has been limited to a few odd transactions. In the United States the demand was sustained right up till the break, and it is estimated that the total sales during December will pass the 40,000-ton mark. This is a higher figure than for November, which was regarded as a rather good month in the copper market. The decision of the copper manufacturers not to advance prices during the closing days of the old year has caused some surprise, but it is suggested that a few of the more important producers wish to see the stocks further reduced before raising the domestic quotation. It is possible that they may be confirmed in this view by the rather colourless condition of the electrolytic copper market in Europe, where, apart from Italian war purchases, there seems little business offering. Fundamentally, however, the position is sound and, taking a long view, the outlook for 1936 is distinctly favourable. The stocks are being steadily depleted and at the present rate of consumption and production should be reduced to normal limits in a few months. The holiday conditions which have ruled in the standard market have operated against any development of interest. Before the holidays a rather weaker tendency was manifested, which was largely due to stop loss orders coming into effect as prices receded. On the resumption of business after Christmas a more cheerful tone was in evidence, but the volume of business was not sufficient to affect quotations greatly. . . . The position in the tin market has shown little change during the past week or two, and in spite of the probability of increased supplies reaching the market the backwardation remains at about £10. This naturally robs the market of its interest for speculators and at the same time puts a stop to a great deal of hedging by consumers. There is considerable doubt as to when the additional supplies resulting from the increase in the quota will reach the market, but the general impression seems to be that it will not be before the end of January or early in February. Buying, both by American and Continental consumers, has been interfered with by the holidays, but it is believed that the former are not well covered, and some extensive buying is expected from that quarter early in the New Year.

Lead and Spelter.

Following the holidays prices in the lead market developed some weakness, which was largely due to sales by producers. It is not surprising that prices receded, as the market was naturally in a somewhat unresponsive state, as many consumers were engaged in stocktaking and disinclined to enter upon fresh commitments until the New Year. There has been a decline in the consumption of lead during December, but this is a normal movement, due to some extent to the restriction of building operations owing to the winter weather. There is a tendency on the part of the market to regard the outlook for 1936 with a certain amount of caution, principally because it is felt that the requirements of the building trades must show a falling off during the next twelve months and also because the present price level offers encouragement to the proudcers to increase production. The fact that the Australian output is likely to be 40,000 tons higher this year than in 1935 is naturally influencing this point of view. It is probable, however, that for some time the manufacturers of lead pipes and sheets will continue to take heavy quantities of pig lead; but, of course, this industry will be amongst the first to reflect any decline in building operations. . . . The spelter market has been rather neglected since the Christmas holidays and prices have fallen slightly, more in sympathy with movements in other non-ferrous markets than for any reason connected with the metal itself. Consumers have shown practically no interest and deliveries have been on a restricted scale. The demand from the galvanising industry fails to develop any strength, but the manufacturers of bearing metals seem to be busily employed and are taking good quantities of spelter. The general belief seems to be that the demand here and on the Continent is sufficient to take care of the stocks, even if it is not strong enough to effect any considerable reduction. In America, where the market has been active for some weeks, the stocks have been reduced, but conditions in that country have practically no influence upon the London market.

Average Non-ferrous Metal Quotations.

The course of prices in the non-ferrous metal markets was disappointing during December. In the case of all the chief metals the average quotations for the month are lower than for November. In the copper market prices were steadier than in other departments, and the average quotation for cash copper showed a drop of 2s. 8d. compared with the November figure, although for three months the decline was only 1s. 7d. The steadiness of the electrolytic copper market during December was shown by the fact that the average price was only 10d. below that for the previous month, whilst for wire bars it is exactly the same. For best selected copper the average, however, was 6s. 8d. less than in November. The fluctuation in the price of tin is reflected in a fall in the average cash quotation for December of £6 11s. 4d. compared with the November figure whilst the average for three months tin fell to the extent of £2 16s. 2d. The weaker tone in the lead market during the concluding weeks of the year was responsible for a drop in the December average for metal "for shipment the current month" of £1 2s. 9d., and for shipment the third following month of £1 2s. 2d. on the November price, whilst the mean was £1 2s. 5d. down. Prices in the spelter market closely followed those of lead during December, and the average "for shipment the current month" fell by £1 2s. 1d. compared with the November figure, and for shipment the third following month by £1 1s. 11d.; the mean also was £1 1s. 11d. lower. The following are the official Metal Exchange quotations for December:—

STANDARD COPPER	Cash (mean)	£35	2	8¾
	3 Months (mean)	£35	11	1½
	Settlement	£35	2	9
ELECTROLYTIC COPPER (mean)		£39	11	3
ELECTROLYTIC WIRE BARS		£39	16	3
BEST SELECTED COPPER (mean)		£38	15	10
STANDARD TIN	Cash (mean)	£220	5	6¾
	3 Months (mean)	£210	2	0
	Settlement	£220	3	9
LEAD	for shipment the current month	£16	16	0¾
	For shipment the third following month	£16	16	6¾
	Mean	£16	16	3¾
	Settlement	£16	16	3
SPELTER	For shipment the current month	£15	1	9¾
	For shipment the third following month	£15	5	6¾
	Mean	£15	3	8¼
	Settlement	£15	2	3

Current Prices for Metals and Fuels.

Makers' official home trade prices per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. COAST—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 10 6	3 2 0
No. 1	3 11 0	3 3 6
Cleveland—	(*D/d Teesside Area*)	
No. 1	3 12 6	3 4 0
No. 3 G.M.B.	3 10 0	3 1 6
No. 4 Forge	3 9 0	3 0 6
Basic (*Less 5/– rebate*)	3 10 0	—
MIDLANDS—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 15 0	—
„ „ Forge	3 10 0	—
Basic (*Less 5/– rebate*)	3 15 0	—
Northampton—		
Foundry No. 3	3 12 6	—
Forge	3 7 6	—
Derbyshire—		
No. 3 Foundry	3 15 0	—
Forge	3 10 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 13 6	—
No. 1 Foundry, ditto	3 16 6	—
No. 3 Foundry, ditto	3 14 0	—
Basic, d/d (*Less 5/– rebate*)	3 10 0	—
N.W. COAST—	3 14 0 d/d Glasgow	
Hematite Mixed Nos.	3 18 6 „ Sheffield	
	4 4 6 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
LANCS.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. YORKS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
MIDLANDS—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
No. 3 quality	7 17 6	—
No. 4 „	8 10 0	—
SCOTLAND—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. COAST—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

LONDON AND THE SOUTH—	Home.	Export.
	£ s. d.	£ s. d.
Angles	8 10 0	7 10 0
Tees	9 10 0	8 10 0
Joists	8 17 6	7 10 0
Channels	8 15 6	7 15 0
Rounds, 3in. and up	9 10 0	8 10 0
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¾in. (basis)	9 0 0	7 15 0
„ ⅝in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅜in.	9 15 0	8 10 0
„ ¼in.	9 10 0	9 0 0
NORTH-EAST COAST—	£ s. d.	£ s. d.
Angles	8 7 6	7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	7 10 0
Channels	8 12 6	7 15 0
Rounds, 3in. and up	9 7 6	8 10 0
„ under 3in.	8 12 0	7 10 0
Plates, ¾in.	8 15 0	7 15 0
„ ⅝in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅜in.	9 10 0	8 10 0
„ ¼in.	9 5 0	9 0 0
Boiler Plates, ¾in.	9 5 0	—
MIDLANDS, AND LEEDS AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	7 10 0
Channels	8 12 6	7 15 0
Rounds, 3in. and up	9 7 6	8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅝in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅜in.	9 12 6	8 10 0
„ ¼in.	9 5 0	9 0 0
Boiler Plates, ¾in.	9 7 6	7 15 0

STEEL (*continued*).

GLASGOW AND DISTRICT—	Home. £ s. d.	Export. £ s. d.
Angles	8 7 6	7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	7 10 0
Channels	8 12 6	7 15 0
Rounds, 3in. and up	9 7 6	8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 15 0	7 15 0
„ ⅝in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅜in.	9 10 0	8 10 0
„ ¼in.	9 5 0	9 0 0
Boiler Plates	9 5 0	—
SOUTH WALES AREA—	£ s. d.	£ s. d.
Angles	8 7 6	7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	7 10 0
Channels	8 12 6	7 15 0
Rounds, 3in. and up	9 7 6	8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅝in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅜in.	9 12 6	8 10 0
„ ¼in.	9 10 0	9 0 0

IRELAND—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¾in. (basis)	9 0 0	9 2 6
„ ⅝in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅜in.	9 15 0	9 17 6
„ ¼in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G. to 13-G., f.o.r.	9 15 0	9 0 0
14-G. to 20-G., d/d	11 5 0	9 10 0
21-G. to 24-G., d/d	11 10 0	9 15 0
25-G. to 27-G., d/d	12 2 6	10 7 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 10 0
2-ton to 4-ton lots	13 17 6
Under 2 tons	15 10 0

Export: £12 15s. 0d., c.i.f. India.
„ £11 15s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18s. 9d.
Tin-plate Bars, d/d South Wales Works, £5 10s. 0d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 to 250 tons	5 17 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 0 0	7/–
„ „ 8 p.c. to 10 p.c.	£21 0 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£33 10 0	11/–
„ „ „ 1 p.c. carbon	£36 5 0	11/–
„ „ „ 0·50 p.c. carbon	£37 5 0	12/–
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose), 76 p.c.	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, December 31st.

COPPER—	
Cash	£35 0 0 to £35 2 6
Three months	£35 8 9 to £35 10 0
Electrolytic	£39 5 0 to £39 15 0
Best Selected Ingots, d/d Birmingham	£39 10 0
Sheets, Hot Rolled	£66 0 0

	Home.	Export.
Tubes, Solid Drawn (basis)	10½d.	10½d.
„ Brazed (basis)	10½d.	10½d.

BRASS—	
Ingots, 70/30, d/d Birmingham	£32 0 0 to £33 0 0

	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9¾d.	9¾d.
„ Brazed	11¾d.	11¾d.

TIN—	
Cash	£218 0 0 to £218 5 0
Three months	£208 0 0 to £208 5 0
LEAD:	£15 12 6 to £15 15 0
SPELTER: Cash and forward	£14 11 3
Aluminium Ingots (British)	£100

FUELS.

SCOTLAND.

LANARKSHIRE—	Export.
(f.o.b. Grangemouth)—Navigation Unscreened	16/– to 16/6
Hamilton Ell	19/– to 19/6
Navigation Splints	19/6 to 20/–
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/– to 16/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	16/6
Unscreened Navigation	16/– to 16/6
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime	17/6
Secondary Steam	16/6

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	14/6 to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	15/6 to 16/6
„ Second	14/6 to 15/–
„ Best Small	11/–
Unscreened	13/– to 14/6
DURHAM—	
Best Gas	14/8
Foundry Coke	19/– to 20/–

SHEFFIELD—	Inland.
Best Hand-picked Branch	26/– to 28/–
South Yorkshire Best	23/– to 25/–
South Yorkshire Seconds	20/– to 21/–
Rough Slacks	11/– to 12/–
Nutty Slacks	10/– to 11/–

CARDIFF— SOUTH WALES.	
Steam Coals:	
Best Admiralty Large	19/6
Best Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Bunker Smalls	12/6 to 13/6
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 27/6
Foundry Coke	27/– to 40/–
Furnace Coke	19/– to 22/6
Patent Fuel	21/–
SWANSEA—	
Anthracite Coals:	
Best Large	36/– to 40/–
Machine-made Cobbles	45/– to 48/6
Nuts	40/– to 48/6
Beans	25/– to 30/–
Peas	19/– to 23/–
Rubbly Culm	11/– to 11/6
Steam Coals:	
Large Ordinary	18/– to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

French Engineering Notes.

(From our own Correspondent in Paris.)

Import Quotas.

THE commercial arrangement just signed with Spain, after a year's negotiations which were more than once broken off, does not suggest that the Continent is yet prepared to modify a commercial policy that is recognised as offering a serious obstacle to international trade recovery. When this country was faced with the necessity of carrying out reforms for an adjustment of national finances, one of the most urgent amongst them was the suppression of import quotas and a return to freer exchanges, and the first decree issued by the Government led to a belief that the country was embarking upon a programme that would remove economic difficulties from which it was suffering. But a decree abrogating quotas for a few engineering products was not followed by the removal of other similar impediments to trade. In the treaty with Spain import quotas are maintained and manipulated as a means of securing reciprocal advantages. Most-favoured-nation treatment is introduced with restrictions, and does not apply to advantages accorded by France to her Colonies and Protectorates. The treaty favours imports of produce from Spain and exports from France to that country, including certain engineering goods and motor cars, the latter being admitted on condition that they are not subject to the bounty on exports provided by the suppression of the turnover tax. The Spanish treaty is based more or less upon the French plan for facilitating trade amongst gold countries. Another treaty for an extension of reciprocal dealings with Luxembourg also provides for a modification of quotas. That the Government is still feeling its way towards a suppression of import quotas is, nevertheless, made clear by a communication from the Minister of Commerce to the effect that it is proposed to grant import licences to all who may require them on payment of a tax which will represent a supertax on coal. The suggestion offers a means of gradually substituting higher import duties for quotas, and coal has apparently been selected for the experiment because it can readily be seen whether it is possible to deal with the problem of dumping by means of tariffs alone. So long as licences have to be obtained they may be refused in cases where dumping is feared. Importers and consumers naturally object to an increase in duties on a raw material like coal, but manufacturers are of the opinion that an extension of the system to all goods and products is worth serious consideration. The only matter upon which everyone is quite agreed is that something must be done rapidly to develop trade with foreign countries.

Foreign Trade.

The continued decline of foreign trade, as revealed by the monthly returns, is accompanied by a corresponding depression of internal activity that shows a complete interdependence between the two, which a large section of the industrial community has always refused to admit, in the belief that a loss of trade with foreign countries could be made good by a development of business with the Colonies. The returns for the first eleven months of the year are significant. The value of imports was 19,001 million francs, a decline of 2227 millions, or about 10·5 per cent. as compared with the corresponding period of 1934, while export values totalled 14,188 million francs, a decrease of 2060 millions, or approximately 13 per cent. Alike in values and tonnage there was a contraction all round, except in the export tonnage of agricultural produce and "material necessary for industry," the former increasing by 515,950 tons, or about 35 per cent., and "material necessary for industry," by 988,252 tons, while the values declined respectively by 35 million francs and 1195 millions. Exchanges with foreign countries fell much more rapidly than with the Colonies, which now count for 28 per cent. in the total exchanges. By far the greater volume of Colonial trade is done with North Africa, which comprises the Department of Algeria and the Protectorates of Tunis and Morocco, so that the Colonial development upon which so much hope has been based has failed to enable this country to be even partially independent of foreign markets, whatever may be the consequences of Colonial economic progress in the future.

The Paris Fair.

The annual Paris Fair will be held from May 26th to June 2nd next. Since it was initiated during the war, the engineering character of the Fair has undergone many changes as the result of varying trade conditions. The participation of foreign makers depends upon the opportunities offered for doing business in this country. A fair can only be really international when foreign makers are free to sell their goods, and they have therefore to decide whether the expense of participating in the show is justified by present or future benefits that are likely to be derived from it. So far as mechanical engineering is concerned, the home industry has made considerable progress under the protection of quotas and other import restrictions, and that protection is pushed a little ahead of what home manufacturers really need and far beyond the interests of machinery users. For what it is worth during the present industrial depression, the market is in the hands of home makers so far as concerns general classes of machinery, but for many special machines and high-duty public works machinery, which is at present produced in this country on only a small scale, users are dependent on foreign manufacturers. Progress in the French industry appears to be limited by the capacity of the home market to absorb particular machines in quantities sufficient to justify their manufacture. It is true that the various branches of the mechanical engineering industry are organised with a view to an ultimate export trade, but that takes little account of the formidable competition they will meet in foreign markets from firms which have far greater facilities for the production of special machines than they possess themselves. For the moment, the only sure thing is that revived prosperity will make this country a valuable market for machinery, and that something will certainly be attempted during the present year to help a recovery that would coincide with the Paris Exhibition of 1937, so that prospects would appear to justify an inquiry by British manufacturers into the most suitable means of keeping their products to the fore in this country.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

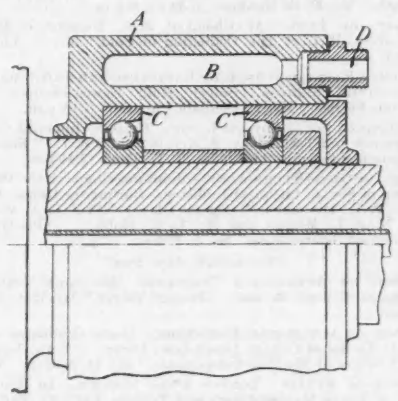
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TRANSMISSION OF POWER.

437,699. December 20th, 1934.—BALL AND ROLLER BEARINGS. C. H. Smith and the Hoffmann Manufacturing Company, Ltd., Chelmsford, Essex.

This invention relates to anti-friction bearings—that is, to ball and roller bearings—which are employed under conditions in which the parts of the bearing are subjected to differential heating. Such conditions are frequently met in practice. A shaft or neck carried in ball or roller bearings may be raised to a comparatively high temperature by being, for example, arranged to carry a steam-heated roll. In such a case the inner race of the bearing becomes hotter than the outer race. The housing A of the inventors' bearing is formed with a chamber B,

Nº437,699



and in order to heat the seatings carrying the outer races C C, so that the relative disposition of the inner and outer seatings, and consequently the races, is maintained the same or substantially the same as when the roll is cold, steam is admitted through the pipe connection D to the chamber B. The chamber is constructed to confine the steam to the exterior of the bearing. Any suitable means for controlling the supply of steam to the chamber may be provided. By maintaining the relative disposition of the seatings in this manner, the bearing may be initially adjusted so that no axial or radial play is present between the shaft and the housing when the parts are cold.—*November 4th*, 1935.

MEASURING AND TESTING INSTRUMENTS.

437,937. June 17th, 1935.—SURVEYING DEEP BORE-HOLES, Gesellschaft für nautische und tiefbohrtechnische Instrumente m.b.H. (formerly known as Gesellschaft für nautische Instrumente G.m.b.H.), Werk Ravensberg, Kiel, Germany, and O. Martienssen.

In the pressure-tight casing A which can be lowered into the water-filled bore, a high-frequency current may be generated in any manner in an oscillatory circuit B. The condenser C of this oscillatory circuit has one of its poles connected with the casing A, which is of good conductivity, and which, in turn, is connected to earth through the water in the bore. The other pole of this condenser is connected to the antenna D. This antenna is a wire which is insulated over its entire length, and also at its end, and which is also insulated where it passes through the casing. The antenna has a capacity in parallel with the condenser and, owing to this capacity, it influences the frequency of the current in the oscillatory circuit. The capacity of this antenna, however, depends upon the properties of the adjacent formation, because the lines of electric force which develop between the individual points of the antenna and the casing of the apparatus extend partly like the lines of force illustrated at XX in the water of the bore, but mainly like the lines of force Y Y in the adjacent formation. Since the dielectric constant of water is about 80, that of sandstone and similar formations 6–8, and that of petroleum about 2, it follows that the capacity of the antenna depends upon the nature of the surrounding formation. If the latter is, for instance, a sand permeated by water, the capacity will be very high; if it is a sand permeated by oil, the capacity will be very low. Therefore when the apparatus is lowered into the bore, the capacity of the antenna, and thus the frequency of the oscillatory circuit in the apparatus, varies in accordance with the character of the adjacent formation.—*November 7th*, 1935.

Nº437,937

METALLURGY.

437,744. May 2nd, 1934.—IRON ALLOYS, Climax Molybdenum Company, No. 295, Madison-avenue, City of New York, U.S.A.

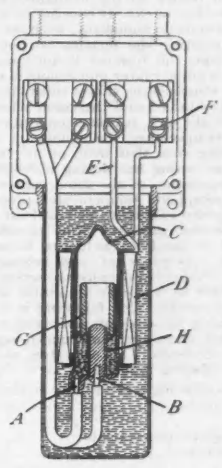
This invention relates to white iron alloys, particularly molybdenum iron alloys, which are particularly adapted to withstand abrasion and are extremely tough and hard. Such a white iron alloy has as its essential ingredients the following elements: iron; carbon from 2·00 to 4·25 per cent.; silicon from 0·20 to 1·0 per cent.; manganese from 1·00 to 2·00 per cent.; and molybdenum from 1·00 to 6·00 per cent. In practising the invention the silicon is kept under 1 per cent. and is as low as is permitted by the methods of casting, in view of the uniform results desired. If an austenitic structure is desired, the silicon must be maintained quite low. Manganese varies from 1·00 to 2·0 per cent. and is used in place of some of the silicon because it does not interfere with the structure as does silicon. Chromium may also be added and, if so, the amount of chromium is determined by the resultant hardness desired, and up to 5·0 per cent. may be used where brittleness is not especially to be avoided. The amount of molybdenum employed may be often as low as 2·0 per cent., and if the silicon is maintained at a very low value the molybdenum may be as low as 1·0 per cent. However, with 1·0 per cent. silicon as much as 6 per cent. molybdenum may be required. In cases where the silicon is held at a low value the molybdenum gives exceptional toughness and wear resistance, and if the molybdenum content is raised it produces an austenitic structure in the alloy. The following is an example of the composition of castings produced in accordance with the invention: Total carbon, 3·5 per cent.; silicon, 0·9 per cent.; manganese, 1·4 per cent.; chromium, 1·0 per cent.; molybdenum, 3·3 per cent. When chill cast, the castings of this composition had a hardness of 578 Brinell on the chilled face and 652 Brinell on the face opposite the chilled face. When sand cast, this alloy produced castings having a hardness of 600 Brinell.—*November 4th*, 1935.

SWITCHGEAR.

438,002. April 24th, 1935.—ELECTRO-MAGNETICALLY OPERATED SWITCHES. M. Payne, 50, Hook-road, Surbiton, Surrey.

In this switch the contacts A and B are sealed hermetically in a glass tube C. Around this tube there is arranged an electro-magnetic coil D with lead-in wires E and F. The assembly is

Nº438,002



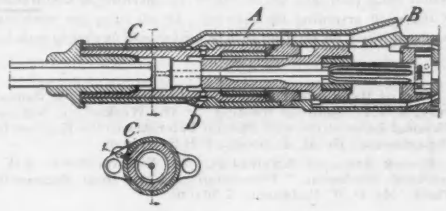
held in a casing filled with pitch. The glass tube contains some mercury on which there floats an iron annulus G. When the coil D is energised the annulus is pulled down and displaces mercury, so that it rises over the top of the insulating sleeve H and completes the circuit between the contacts A and B.—*April 24th*, 1935.

MINING MACHINERY.

438,013. June 20th, 1935.—ROCK DRILLS, *W. W. Triggs, Marks and Clerk, 57 and 58, Lincoln's Inn-fields, London, W.C.2.*

It is pointed out that whilst most of the working parts of a rock drill are generally lubricated by oil entrained by the compressed air, the bearing of the drill itself, or its sleeve, in the front end of the body seldom receives such attention. To

Nº438,013



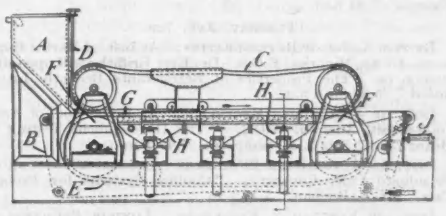
meet this drawback the inventors take a branch A from the main air exhaust B and lead part of this air to the front end of the tool, where it is spread around the bearing by the semi-circular groove C and finally escapes at D. It is said that if the lubricator supplying oil to the air line is properly adjusted there will be sufficient oil in the exhaust to lubricate the bearing.—*November 8th*, 1935.

WATER PURIFICATION.

437,892. May 7th, 1934.—EXTRACTION OF LIQUID FROM SLUDGE, W. R. Thomson, 99A, Bloor-street West, Toronto, Ontario.

In this machine the wet sludge is fed from the hopper A on

Nº437,892



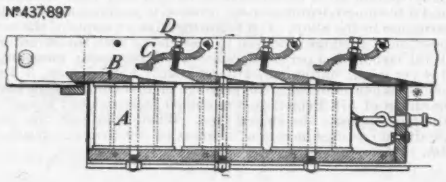
to the fine mesh belt B. It is confined sideways by the deckle straps C, which travel with it, while its thickness is regulated by the gate D. Beneath the belt there is a continuous mat E passing over the pulleys F F. This mat has a series of transverse grooves G open at the top. The ends of these grooves register with ports in the tops of the suction boxes H H, which are

connected to a pump to draw off the liquid. The dewatered cake is discharged over the end of the belt on to the transverse conveyor J.—*November 7th*, 1935.

MISCELLANEOUS.

437,897. May 12th, 1934.—MAGNETIC SEPARATORS, Electromagnets, Ltd., 2, Church-street, Colmore-road, Birmingham, and W. E. Box.

In this separator the magnet windings are shown at A and



the pole pieces at B. Above the pole pieces there are hinged induction bars C with serrated undersurfaces. The position of these bars can be adjusted by the screws D. The induction bars, it will be seen, overlap the following pole pieces.—*November 7th*, 1935.

437,928. April 2nd, 1935.—THE MANUFACTURE OF RUBBER COMPOSITIONS FROM RUBBER LATEX, B. Wilkinson, 1–4, Great Tower-street, London, E.C.3.

This invention relates to the manufacture of rubber compositions from rubber latex. It consists in incorporating with the latex a vulcanising ingredient, such as sulphur, and an accelerator, coagulating the mixture so obtained, separating the coagulum from the residual liquor, preparing from the coagulum sheet or crepe rubber and drying it at such a temperature, preferably atmospheric, that a substantially unvulcanised dried product is obtained and thereafter effecting a very slow vulcanisation of the dry rubber composition by keeping it at atmospheric temperature, the amount of accelerator added to the latex being such that little or no vulcanisation takes place prior to or during the drying operation, and that the subsequent vulcanisation of the dried rubber, by maintaining it simply at atmospheric temperatures, proceeds very slowly and occupies a period extending from at least about one or two weeks up to several months. The amount of vulcanising materials added to the latex is limited to such quantities as to prevent the occurrence of over-vulcanisation with the passage of time. Preferably to assist the action of the accelerator there is also added to the latex a suitable activator such, for example, as zinc oxide. The following is a description of a method of carrying the present invention into effect :—With fresh rubber latex there are compounded aqueous dispersions of sulphur, an accelerator, an activator, and some colouring material in the following proportions :—

Rubber latex having a dry rubber content of	100 lb.
Sulphur	3 lb.
Zinc oxide	9 lb.
Zinc dimethyldithiocarbamate	4 oz.
Colouring matter	8 oz.

The material has exceptional resistance to abrasion and tearing. Thus sheets of the material produced by the present process of convenient length, breadth, and thickness may be shipped to any part of the world, kept in stock for long periods without fear of deterioration, and, when required, can be built up by the use of a simple cold cementing process into any desired shape for various uses, especially in mining and engineering, for the prevention or reduction of abrasion, corrosion, and vibration.—*November 7th*, 1935.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Informal meeting. "The Work of the National Physical Laboratory, with Special Reference to the Engineering Department," Dr. H. J. Gough, F.R.S. 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Informal discussion, "Prevention of Noise from Engineering Plant," Mr. D. W. McJannet. 7.30 p.m.

SATURDAY, JAN. 4TH.

INST. OF ENGINEERS-IN-CHARGE.—Visit to Battersea Power Station, S.W.8. 2.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. —Christmas Lecture, "Photography : IV—Motion Picture Photography," Dr. C. E. K. Mees. 3 p.m.

MONDAY, JAN. 6TH.

BRADFORD ENGINEERING SOC.—Technical College, Bradford. "Industrial Power," Mr. W. Dundas. 7.30 p.m.

CHARTERED SURVEYORS' INST.—12, Great George-street, S.W.1. Mr. Charles Latham will open discussion, "The Rating of Empty Properties." 6.30 p.m.

INST. OF PRODUCTION ENGINEERS.—College of Technology, Manchester. "Industrial Relations," Mr. A. Ramsay. 7.30 p.m.

ROYAL AERONAUTICAL SOC.—At Inst. of Electrical Engineers, Savoy-place, W.C.2. "Sir George Cayley—Founder of Modern Aeronautical Science," Mr. J. E. Hodgson. 6.30 p.m.

SOC. OF GLASS TECHNOLOGY : MIDLAND SECTION.—Talbot Hotel, Stourbridge. "History of Optical Glass," Mr. W. H. S. Chance. 7.30 p.m.

TUESDAY, JAN. 7TH.

BRITISH ASSOC. OF REFRIGERATION.—At Inst. of Marine Engineers, 85–88, Minories, E.C.3. Dr. Ezer Griffiths will open discussion on "The Properties of Refrigerants Recently Introduced." 5.30 for 6 p.m.

INST. OF AUTOMOBILE ENGINEERS.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. "The Development Testing of Motor Cars," Mr. C. M. Simpson. 7.45 p.m.

INST. OF AUTOMOBILE ENGINEERS.—Graduates' meeting at Broadgate Café, Coventry. "Cooling Systems for Private Cars," Mr. J. Buchan. 7.15 p.m.

INST. OF ELECTRICAL ENGINEERS : LONDON STUDENTS.—Visit to Associated Newspaper Printing Works, Carmelite-House, E.C.4. 11 p.m.

INST. OF ELECTRICAL ENGINEERS : N. MIDLAND CENTRE.—Hotel Metropole, Leeds. Informal discussion on "Electrical Vehicles." 6.30 for 7 p.m.

INST. OF SANITARY ENGINEERS.—Caxton Hall, S.W.1. Presidential address, Mr. G. T. Cotterell. 5.45 for 6 p.m.

PHYSICAL SOC.—Physics Lecture Theatre, Imperial College of Science and Technology, S. Kensington, S.W.7. "Some Instruments used in Recording Sound in Films," Mr. R. A. Bell. 7.45 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. —Christmas Lecture, "Photography : V—Some Applications of Photography," Dr. C. E. K. Mees. 3 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. Annual general meeting. Presidential address by Prof. J. H. Andrew. 7.30 p.m.

SOC. OF GLASS TECHNOLOGY.—Trocadero Restaurant, Piccadilly, W.1. Annual dinner and dance. 7 for 7.15 p.m.

TUESDAY, JAN. 7TH, TO THURSDAY, JAN. 9TH.

PHYSICAL SOC.—Imperial College of Science and Technology, S. Kensington, S.W.7. Annual Exhibition. Open daily : Tuesday, 3 to 6 p.m.; 7 to 10 p.m. Wednesday, 2 to 4 p.m.; 7 to 10 p.m. Members, 4 to 6 p.m. Thursday, 3 to 6 p.m.; 7 to 10 p.m.

TUESDAY TO FRIDAY, JAN 7TH TO 10TH.

INSTITUTE FOR RESEARCH IN AGRICULTURAL ENGINEERING.—Rhodes House, Oxford. Joint conference on "Mechanisation in Mixed Farming." Tuesday, Rhodes House. Inaugural dinner, 7.45 p.m. Wednesday, Thursday and Friday, 9.30 a.m.

WEDNESDAY, JAN. 8TH.

INST. OF ENGINEERS-IN-CHARGE.—St. Bride Inst., Bride-lane, E.C.4. "Boiler-house Efficiency," Mr. V. R. Chadwick. 6.30 for 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS : WIRELESS SECTION.—Savoy-place, Victoria Embankment, W.C.2. "The Radiation Resistance of Aerials whose Length is Comparable with the Wave Length," Mr. E. B. Moullin. 5.30 for 6 p.m.

INST. OF FUEL.—At Chemical Soc., Burlington House, Piccadilly, W.1. "The Dedusting of Coal," Mr. G. Lindley. 6 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS : GRADUATES' SECTION.—Bolbec Hall, Newcastle-upon-Tyne. "Train Ferries," Mr. P. Denham Christie. 7.15 p.m.

PHYSICAL SOC.—Physics Lecture Theatre, Imperial College of Science and Technology, S. Kensington, S.W.7. "Electrical Measurements before 1886," Mr. R. W. Paul. 7.45 p.m.

SOC. OF GLASS TECHNOLOGY.—Joint meeting with the Plastics Group of Soc. of Chemical Industry. Burlington House, Piccadilly, W.1. Discussion, "Organic Glasses," Prof. G. T. Morgan, Mr. N. J. L. Megson, and Mr. L. E. Holmes ; "Plastics for Laminated Safety Glass," Mr. J. Wilson. 2 p.m.

THURSDAY, JAN. 9TH.

INST. OF AUTOMOBILE ENGINEERS.—Merchant Venturers' Technical College, Bristol. "Rotary Valves," Mr. R. C. Cross. 7 p.m.

INST. OF AUTOMOBILE ENGINEERS.—Derby Graduates' meeting at Technical College, Green-lane, Derby. "Some Notes on the Failures of Machine Components," Mr. D. Nelson. 7 p.m.

INST. OF METALS : LONDON LOCAL SECTION.—In Rooms of Soc. of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. "Metals of the Platinum Group," Mr. R. H. Atkinson. 7.30 p.m.

RAILWAY CLUB.—At Royal Scottish Corporation Hall, Fetter-lane, E.C.4. "Story of a Railway Waif (the Invergarry and Fort Augustus Railway)," Mr. H. A. Vallance. 7.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. —Christmas Lecture, "Photography : VI—Photography in Natural Colours," Dr. C. E. K. Mees. 3 p.m.

FRIDAY, JAN. 10TH.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Thomas Lowe Gray Lecture, "The Future of Steam Propulsion," Mr. J. Johnson. 6 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Refractory Materials," Dr. J. H. Partridge. 7.30 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS. —At Mining Inst., Newcastle-upon-Tyne. "Relation of Laboratory Research to Engine Design," Dipl.-Ing. H. Hauttmann. 6 p.m.

SATURDAY, JAN. 11TH.

INST. OF AUTOMOBILE ENGINEERS.—Graduates' visit to works of Tecalemit Ltd., Great West Road, Brentford. 2.30 p.m.

INST. OF ELECTRICAL ENGINEERS : N. MIDLAND STUDENTS.—Visit to Post Office Telephone Exchange, Leeds.

INST. OF ENGINEERS-IN-CHARGE.—St. Bride Inst., Bride-lane, E.C.4. Social dance.

INST. OF MARINE ENGINEERS : JUNIOR SECTION.—85–88, The Minories, London, E.C.3. Dance. 7.30 to 11.15 p.m.

MONDAY, JAN. 13TH.

INST. OF ELECTRICAL ENGINEERS : WESTERN CENTRE.—Royal Hotel, Cardiff. Annual dinner and dance. 6.30 for 7 p.m.

INST. OF METALS : SCOTTISH LOCAL SECTION.—Joint meeting with Inst. of Automobile Engineers, in Rooms of Inst. of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow, C.2. "Fatigue in Relation to Automobile Engineering," Capt. L. W. Johnson. 7.30 p.m.

TUESDAY, JAN. 14TH.

ILLUMINATING ENGINEERING SOC.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. Mr. F. E. Lamplough will introduce discussion on "Applications of Ultra Violet Light and some Aspects of Fluorescence and Phosphorescence." 6.30 for 7 p.m.

INST. OF ELECTRICAL ENGINEERS : N. MIDLAND STUDENTS.—Hotel Metropole, Leeds. Problems' Night. 7.15 p.m.

INST. OF ELECTRICAL ENGINEERS : WIRELESS SECTION.—Savoy-place, Victoria Embankment, W.C.2. Sir Noel Ashbridge will open discussion on "Ultra Short Waves for Broadcasting." 6 for 6.30 p.m.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Echo-sounding Equipment for Ships," Captain J. F. Hutchings. 7.30 p.m.

INST. OF MARINE ENGINEERS.—85–88, The Minories, E.C.3. "The Care and Maintenance of a Modern Diesel-engined Tanker Fleet," Mr. H. S. Humphreys. 6 p.m.

INST. OF METALS : BIRMINGHAM LOCAL SECTION.—James Watt Memorial Inst., Birmingham. "Light Alloys," Mr. H. G. Warrington. 7 p.m.

CALENDARS, DIARIES, &c.

ASSOCIATED BRITISH MACHINE TOOL MAKERS, Ltd., 17, Grosvenor-gardens, S.W.1.—Wall calendar.

ASSOCIATED EQUIPMENT COMPANY, Ltd., Southall, Middlesex. —Engagement pad, greeting card.

ASHWELL AND NESBIT, Ltd., Barkby-lane, Leicester.—Wall calendar.

AVELING-BARFORD, Ltd., Grantham.—Greeting card.

BRAITHWAITE AND CO. ENGINEERS, Ltd.—Pocket diary.

BRISTOL AEROPLANE COMPANY, Ltd., Filton, Bristol.—Wall calendar.

BRITISH INSULATED CABLES, Ltd., Prescot, Lancs.—Wall calendar.

BRITISH JEFFREY-DIAMOND, Ltd., Wakefield.—Wall calendar.

BRITISH STEEL PILING COMPANY, Ltd., Thames House, Millbank, S.W.1.—Greeting card.

CARBORUNDUM COMPANY, Ltd., Trafford Park, Manchester. —Wall calendar.

COUNTY OF LONDON ELECTRIC SUPPLY COMPANY, Ltd., County House, 46–47, New Broad-street, E.C.2.—Wall calendar.

CRAVEN BROTHERS (Manchester), Ltd., Reddish, Stockport. —Wall calendar.

DEMAG AKTIENGESELLSCHAFT, Duisburg.—Refill for desk calendar frame.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, 16, Old Queen-street, S.W.1.—Greeting card.

"THE DRAUGHTSMAN," 96, St. George's-square, London, S.W.1.—The Association of Engineering and Shipbuilding Draughtsmen Diary, 1936.

F. J. EDWARDS, Ltd., 359–361, Euston-road, N.W.1.—Greeting card.

ELECTRICITY SUPPLY COMMISSION, Johannesburg.—Greeting card from the Chairman, Commissioners, and staff.

GEORGE ELLISON, Perry Barr, Birmingham, 20.—Greeting card.

EVERSHED AND VIGNOLES, Ltd., Acton-lane Works, Chiswick, W.4.—Wall calendar.

B. J. HALL AND CO., Ltd., 1, Kingsway, W.C.2.—Wall calendar.

R. AND W. HAWTHORN, LESLIE AND CO., Ltd., Newcastle-upon-Tyne.—Wall calendar.

HEWITTIC ELECTRIC COMPANY, Ltd., Walton-on-Thames, Surrey.—Greeting card.

HYLAND, Ltd., Wakefield.—Chart weight and ash tray.

JAPANESE MINISTRY OF RAILWAYS, Brettenham House, Lancaster House, Lancaster-place, W.C.2.—Greeting card.

WM. JESSOP AND SONS, Ltd., Sheffield.—Greeting card.

KELLY AND SONS, Portugal-street, London, W.C.2.—Engagement pad.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., Trafford Park.—Art wall calendar.

MORRIS MOTORS, Ltd., Cowley, Oxford.—Greeting card, wall calendar, pocket diary.

C. A. PARSONS AND CO., Ltd., Heaton Works, Newcastle-upon-Tyne, 6.—Wall calendar.

PETRO-FLEX TUBING COMPANY, Ltd., Cassiobury Works, St. Albans-road, Watford, Herts.—Wall calendar.

GEORGE REVEIRS, Ltd., 10–12, Rosebery-avenue, E.C.1.—Greeting card.

RUSTON AND HORNSBY, Ltd., Lincoln.—Wall calendar.

RUSTON-BUCYRUS, Ltd., Lincoln.—Wall calendar.

HENRY SIMON, Ltd., Cheadle Heath, Stockport.—Calendar.

SPOTTISWOODE, BALLANTYNE AND CO., Ltd., 1, New Street-square, E.C.4.—Wall calendar.

STANTON IRONWORKS COMPANY, Ltd., near Nottingham.—Pocket diary.

STAVELEY COAL AND IRON COMPANY, Ltd., near Chesterfield.—Pocket diary.

STEWARTS AND LLOYDS, Ltd., Glasgow, Birmingham, and London.—Desk calendar.

J. STONE AND CO., Ltd., Deptford.—Diary.

SWITCHGEAR AND COWANS, Ltd., Elsinore-road, Old Trafford, Manchester, 16.—Greeting card.

THAMES BOARD MILLS, Ltd., Purfleet, Essex.—Greeting card.

JOHN TULLIS AND SON, Ltd., St. Ann's Works, Glasgow, S.E. —Engagement pad.

G. AND J. WEIR, Ltd., Cathcart, Glasgow, S.4.—Greeting card.

FRANK WIGGLESWORTH AND CO., Ltd., Shipley, Yorks.—Blotter.

WILLIAMS, LEA AND CO., Ltd., Clifton House, Worship-street, London, E.C.2.—Wall calendar.

EDWARD WOOD AND CO., Ltd., 68, Victoria-street, S.W.1.—Diary.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

F. W. BRACKETT AND CO., Ltd., Colchester, have been awarded a contract for the supply of a circulating water screen, together with accessories, for the Southampton Corporation. The screen will be of the "Central Flow" type, and will have a capacity of 1,750,000 gallons per hour at the lowest water level.

THE MIRRLEES WATSON COMPANY is to receive the contract for the supply of the steam surface condensing plants in connection with the 50,000-kW sets being supplied by C. A. Parsons for the Dalmarnock power station, Glasgow. Each condenser will be complete with circulating pump, duplicate three-stage steam ejector air pumps, and duplicate vertical-spindle, two-stage condensate pumps.

LAUNCHES AND TRIAL TRIPS.

EMPIRE STAR, motor vessel ; built by Harland and Wolff, Ltd., to the order of the Blue Star Line, Ltd.; dimensions, 535ft. 6in. by 70ft. by 43ft. 4½in.; to carry passengers and cargo. Diesel engines, Harland-B. and W. type ; constructed by the builders ; trial trip, recently.

MACTRA, motor vessel ; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of The Anglo-Saxon Petroleum Company, Ltd.; dimensions, 425ft. by 54ft. 3in. by 31ft.; to carry oil in bulk. Oil engines of Werkspoor type ; launch, December 27th.

CREEP-RESISTING STEEL.—We have received from the United Steel Companies, Ltd., a copy of their recent publication on "Durehete" creep-resisting steel, which has been prepared by the Central Research Department of the company in co-operation with interested users of the steel. "Durehete" is claimed to be free from embrittlement and capable of resisting scaling up to a temperature of about 932 deg. Fah., and it is owing to these properties that it is referred to as a "creep-resisting," rather than a "heat-resisting" metal by the makers. The book deals very thoroughly with the steel, giving details of its physical and general properties, the results of a series of tests at high temperatures, and tests for its resistance to embrittlement. The various tests are illustrated by graphs and a number of National Physical Laboratory test reports are reproduced. The book will doubtlessly be of much interest to those whose work is in connection with high steam temperatures, and particularly to those who have studied the paper by Mr. R. W. Bailey on the "Utilisation of Creep Test Data in Engineering Design," presented before the Institution of Mechanical Engineers on November 22nd last.

A Seven-Day Journal

New Automobile Research Laboratories.

THE Institution of Automobile Engineers announces that it has acquired new premises for its research laboratories on the Great West-road, Brentford, near to the Firestone factory. The front of the new building consists of a two-storey block, which will accommodate the general offices, library, and committee room. At the rear of the building will be sections for the physical and chemical testing of materials, a bay for the testing of complete vehicles, and another for the simultaneous testing of as many as eight engines. In addition, there is a car park and a further building beyond, which, besides accommodating the stores and the workshops, contains another bay in which several independent researches can be carried on. The new laboratories are now being equipped, and it is hoped that they will be opened in the early spring. We may recall that most of the Institution's investigations have been carried out at the old Chiswick laboratories, which consist of a large private house with a workshop at the rear. For some time past the need of more commodious laboratories has been keenly felt. The need for larger premises is shown by the fact that whereas four years ago only one item was on the programme of research, work is now being undertaken on no less than ten. Over the same period the number of manufacturers and vehicle operators affiliated with the Institution has increased from 28 to 180.

A New Tunnel for New York.

ACCORDING to the New York correspondent of *The Times*, with the grant of a sum of £11,673,000 by the Federal Government, of which a certain part will cover about 30 per cent. of the cost of labour and materials, and the remainder form a loan, it seems very likely that work will shortly be begun on a new vehicular tunnel under East River, between Midtown Manhattan and the borough of Queens. Before work can begin, however, it will be necessary for the New York State Legislature to pass amendments to the Act which created the Queens Midtown Tunnel Authority, increasing the security for the loan, which forms the largest part of the grant above referred to. If these amendments are quickly passed work may begin in a few weeks' time. The tunnel will consist of two tubes, each carrying two lines of traffic in one direction. They will provide a headroom of 13½ft. with roadways 21ft. wide. The length between the ventilating shafts on the opposite shores of the river will be about 1263 yards, and on the Manhattan side there will be an approach of 533 yards, and on the Queens side one of about 800 yards. Ultimately the tunnel will be extended under Newtown Creek in order to connect the boroughs of Queens and Brooklyn. Tolls will be levied to meet all services on the bonds and to retire them in not more than fifty years, after which the tunnel will become City property. Some doubt may be expressed as to whether this scheme, so far as it is dependent upon a grant from the Federal Government, will not be jeopardised by the repercussions of the Supreme Court's decision declaring the Agricultural Administration Act illegal.

The New Holland-America Liner.

AT the beginning of the year the first keel plates of the new Holland-America Line steamer, which will be a sister to the Harland and Wolff built "Statendam," were laid on a berth which has been specially reconstructed in the yard of the Rotterdam Dry Dock Company. The new liner is of interest as being the largest ship to be constructed in Holland. Another point of interest is that no less than four different shipbuilding firms will contribute their share to the completion of the vessel. While the main hull will be built at the Rotterdam Dry Dock Company's yard, the stem and some of the forepart of the hull is to be constructed by the Machinefabriek and Scheepswerf van P. Smit, Jnr., other parts of the hull being supplied by the Wilton-Fijenoord Shipbuilding Company, of Schiedam. The main propelling machinery, which will comprise geared steam turbines and Yarrow boilers, is to be be supplied by the De Schelde Royal Shipbuilding Company, at Flushing.

The Coal Industry.

THE recent question as to the wages which can be paid by the coal industry to its miners has shown that wide discrepancies exist in different parts of the country, and that the miners are unlikely to be satisfied with any of the offers which the owners can make. In South Wales an offer has been made to increase the "minimum percentage" wage and the "subsistence wage" in such a manner as will benefit the lowest paid pieceworkers and the day wage men. It is based on the assumption that 1s. a ton more is received from inland coal consumers, always excepting the railways and other consumers who refuse to pay the higher price. The reasons for the refusal of the main line railway companies to pay the extra shilling a ton on long-term contracts are given in a letter of Sir Ralph Wedgwood, chairman of the railway general managers, to Sir Evan Williams, President of the Mining Association of Great Britain. It points out that even if railway companies had a means of increasing their charges in proportion to costs, such an increase might fail to result in any increase of revenue. That, to be effective, such an increase would have to be limited to the rates charged for the carriage of coal, of raw materials, and of some of the products of the heavy industries, an increase the railways are unwilling to make at the present moment. Imperial Chemical Industries, Ltd., has notified the Secretary of Mines that it is prepared to agree to an advance of 1s. a ton on coal in all forward contracts in the United Kingdom without increasing the sale price of its own commodities. It is estimated that the I.C.I. consumes about 2,500,000 tons of coal per annum, so that the increase will involve a further £125,000 per annum on the cost of its coal. Several gas and electricity undertakings, as well as public bodies which are large coal consumers, have also agreed to pay the extra shilling a ton.

The Humber Bridge Scheme.

ON more than one occasion we have referred in these columns to the proposal to bridge the Humber, which was raised in 1930, but had to be abandoned because of the financial crisis. The scheme is again under consideration by the Ministry of Transport, and it embodies, we understand, a proposal for the building of a suspension bridge, with a span longer than any existing single span in Europe. The estimated cost of the proposed bridge is about £2,600,000, which is £900,000 more than that of the bridge proposed under the 1930 scheme. If the new plans are approved for Government assistance it is expected that a grant of 75 per cent. of the cost will be made by the Ministry of Transport. It is further suggested that the Hull Corporation should contribute £200,000, leaving a balance of £500,000 to be raised by the participating local authorities on both the Yorkshire and Lincolnshire sides of the river. Negotiations are now going on between the Hull Corporation Parliamentary Committee and the county, town, and urban councils, which have interests in the scheme. At the request of the Ministry of Transport plans of the proposed bridge are being prepared for the consideration of Government experts.

London and North-Eastern Railway Programme.

THE London and North-Eastern Railway recently decided to put into force an extensive programme of renewal, to be completed during 1935–36, independently of such work as will be carried out under the terms of the Government-assisted loan, mentioned in a Journal note of January 3rd. It will provide for the construction of some 207 locomotives, 1154 passenger coaches, 11,046 wagons, 50 horse-boxes, 500 locomotive coal wagons, and 780 containers. Some of the locomotives and wagons are already in service. Eighteen of the locomotives are for express passenger service and four of these are already on the "Silver Jubilee" service. The remaining fourteen are to be of the "Sandringham" 4–6–0 type. A further 125 locomotives are of the 2–6–0 and 0–6–0 fast goods and passenger types, and 18 will be of the suburban passenger tank, three-cylinder, 2–6–2 design. The passenger stock includes a new train for the Hook and Antwerp Continental boat train service. A large number of vacuum brake equipped goods stock is included. It is intended to renew some 466 miles of track and to recondition 56 bridges, while 354 stations are to be redecorated. In addition to this programme, the London and North-Eastern Railway has placed orders to the value of £130,000 for new locomotives and rolling stock under the Government-assisted loan scheme. They include ten three-cylinder 2–6–0 locomotives, to be built by Sir W. G. Armstrong, Whitworth and Co., of Newcastle : sixteen vestibuled open third-class carriages, to be built by the Metropolitan Carriage and Wagon Company, Ltd., of Birmingham ; and eight similar vehicles, to be built by the Birmingham Carriage and Wagon Company, Ltd., of Smethurst.

Steel Cartel Discussions.

THE discussions which took place at the meeting of the British and Continental steel makers at Brussels at the beginning of this week covered several matters of considerable interest to both parties. The most urgent question under consideration probably was that of the best method of handling the imports of Continental steel, which is dealt with at length in our "Market Notes and News." Apart from this, the working of the arrangement entered into last August has provided a number of problems which required to be dealt with. These, however, it is understood, did not present much difficulty. The work of filling in the details of the export agreement between the British steel makers and the Cartel was proceeded with, the intention being to regulate the prices of British and Continental steel in all the overseas markets. For some weeks now an understanding has existed with regard to steel plates, the price for which has been fixed for practically every export market, the British quotation being slightly higher than that asked by the Continent. It is understood that special attention was paid to the position in the South African market, where the German steel makers claim to be entitled to special consideration, although it is primarily, of course, a British market. It has been suggested that a tonnage quota may be arranged for each country in the Cartel, including Great Britain, and that this should be fixed for South Africa at a figure which would check any inducement to cut prices. Little progress is said to have been made with the thorny question of an export arrangement between the British and Continental galvanised sheet manufacturers and thin black sheet makers.

The Naval Conference.

ON Monday, January 6th, the Naval Conference resumed its sittings, after the Christmas adjournment, and Lord Monsell presided at a full meeting of the First Committee, which was held at Clarence House, Westminster. Mr. Anthony Eden, the Foreign Secretary, succeeded Sir Samuel Hoare as President of the Conference. Discussion was continued on the British proposal for quantitative limitations, under which it is suggested that each Power should announce its proposed amount of construction six years ahead, in order that competition may be avoided. The details of the British proposals were further criticised, in particular the suggested period of six years, and both France and Italy proposed a much shorter period of six months and a year, respectively. At Monday's meeting the British, French, and Italian delegations undertook to draw up detailed proposals for the procedure for the exchange of information and the general scope of the information which might be exchanged. On Tuesday these proposals were circulated for independent examination by the different delegations before a general discussion on them took place. That discussion was arranged for Wednesday, January 8th.

Coast Preservation at Bournemouth.

ON Tuesday, January 7th, the Bournemouth Borough Council approved a scheme which, it is expected, will cost close upon £19,000, for preventing the erosion of the cliffs on the western side of Hengistbury Head and stopping the present serious denudation of the sandbank east of the same Head, which forms the eastern extremity of Bournemouth Bay. It was decided that the Borough Engineer should approach Trinity House in order to obtain official sanction for the scheme. The proposal is to build a groyne about 700ft. long out to sea, which will fill the gap between the seaward end of Hengistbury Head and the line of the half sunken Beer Pan Rocks. At present there is a strong current running through this gap, which carries away the sand and shingle which would otherwise pile up on the western side of the rocks and so protect the cliffs and the headland. This current has also had the undesirable effect of carrying away sand from the bank east of Hengistbury Head, which protects the entrance to Christchurch Harbour against the full force of the sea and tide. It is hoped that the work may soon be begun on the Engineer's scheme, which should go far to prevent the cliff erosion now taking place.

Floods in France.

THE worst floods which have taken place in France for the last twenty-five years are now affecting some twenty departments. The Loire has carried away the suspension bridge of Montjean, some miles above Nantes, and is flooding a large part of the town itself. The Divatte dyke, which protects a large area of reclaimed fenland, now a thickly populated market gardening district, is threatened. Should the river continue to rise, the authorities will have to choose between cutting the dyke and allowing a disastrous rise of the water in Nantes itself. To cut the Divatte dyke will mean that the area beyond will be flooded some 20ft. deep in a matter of hours. Communications between Nantes and Saumur by rail have been broken. The Seine is still 12ft. below the 1910 level, and is expected to fall. Some small areas in Paris are flooded. The Garonne, Dordogne, and Adour are all causing floods, and some dykes have given way, causing damage to vineyards and farms at Barsac and other places. The main Bordeaux–Toulouse road has been cut. Poitiers, Lyons, Macon, and Chalons are all partly flooded. In the Alps, numerous landslides have occurred and roads have been cut, notably at Chaumont, near Grenoble, and at Valence-sur-Rhone. Quiberon peninsula is in danger of becoming an island, owing to the attacks made by the heavy seas beating on the narrow neck of land joining the peninsula to the mainland. The neck in places is only wide enough to carry the road and the railway line which lead to the town.

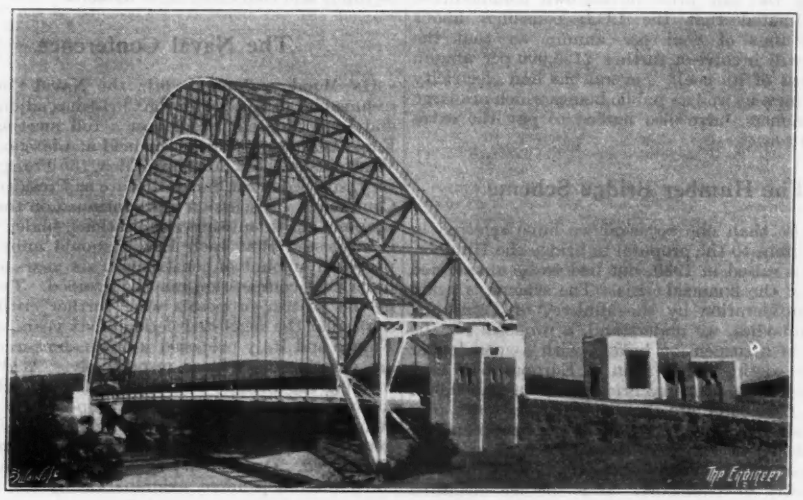
Roads, Bridges and Tunnels in 1935.

No. II.

(*Concluded from page 10, January 3rd.*)

Africa.

EVEN in countries which by European standards are not well developed, roads are assuming an importance great enough to warrant the construction of large bridges to carry them over impediments. A typical example is the Birchenough Bridge over the Sabi River, in Southern Rhodesia, opened as recently as December 20th, by Sir Herbert Stanley. This bridge, built for the Beit Railway Trust by Dorman, Long and Co., Ltd., of Middlesbrough, under the direction of Mr. Ralph Freeman, of Sir Douglas Fox and Partners, lies about 80 miles south of Umtali, the nearest point on the Rhodesian State Railways. It is a two-hinged braced steel arch structure with a span of 1080ft. and a width between trusses of 45ft. From the springing the rise to the crown of the arch is 250ft. On the west it is approached by two-deck-plate girder spans of 60ft. and 40ft. and on the east by one similar span of 60ft. At high flood level of the river the deck gives a clearance of 30ft. It carries an 18ft. roadway and two 3ft. footpaths. The total weight of steel in the bridge is 1650 tons, of which all but 200 tons are Chromador steel. Erection of the bridge was carried out by a method very similar to that adopted for the Sydney arch bridge. The steel work was cantilevered out from each bank, being tied back by steel wire cables anchored off in tunnels in the rock behind the abutments. There were six cables for each arch truss. The steel was erected by derrick cranes travelling on top of the arch trusses and was carried to the cranes by a Blondin cableway spanning the river.

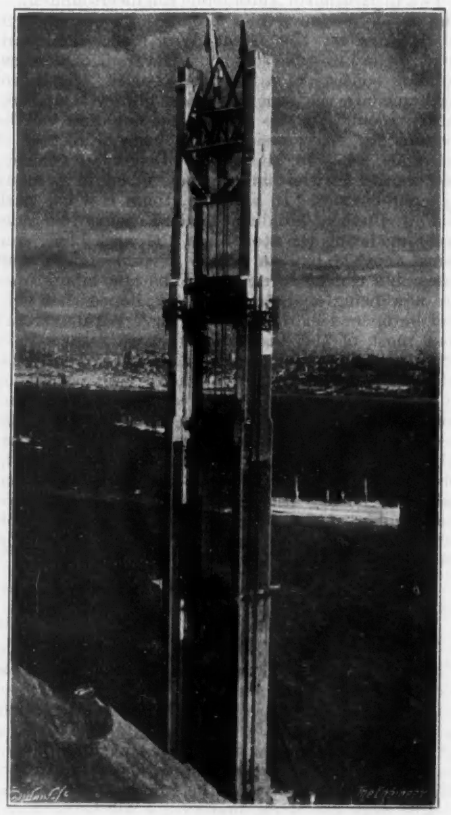


THE BIRCHENOUGH BRIDGE, RHODESIA

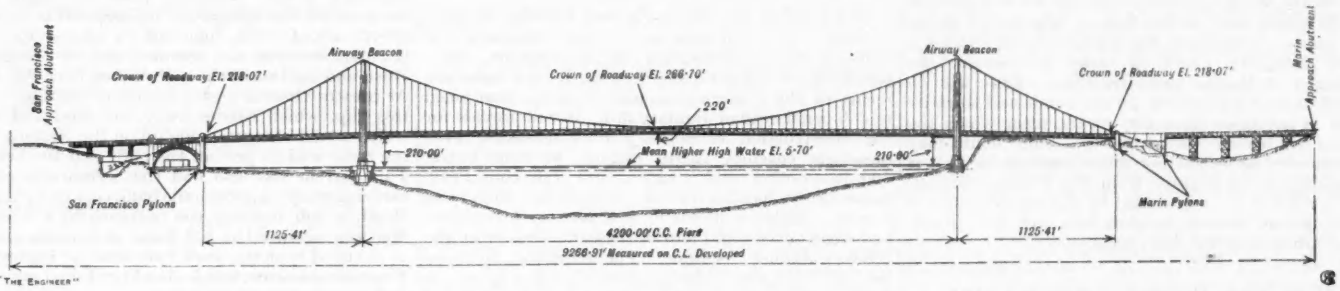
America.

Two bridges in America are of such outstanding importance that the progress in their construction overshadows work upon all others. The Golden Gate bridge, which is to have a central suspension span of 4200ft. between centres of piers, is notable for the grandeur of its conception and for the fact that it will cross the entrance to one of the great natural harbours of the world in a position which will expose it to the full force of Pacific storms. While the San Francisco-Oakland bridge has no such enormous spans and crosses the harbour over sheltered waters, its total length approaching 8 miles and the manner in which the two main suspension spans are anchored at their outer ends to a great pier 226ft. high makes it almost as notable a work. In drawings reproduced with this article we show diagrammatic elevations of the two structures from which the main dimensions can be seen, while a number of other engravings show the progress of the work. It is, even to one brought up in this era of road transportation, astounding that it should have been found worth while to erect such great and costly structures for the use entirely of road vehicles and inter-urban electric cars.

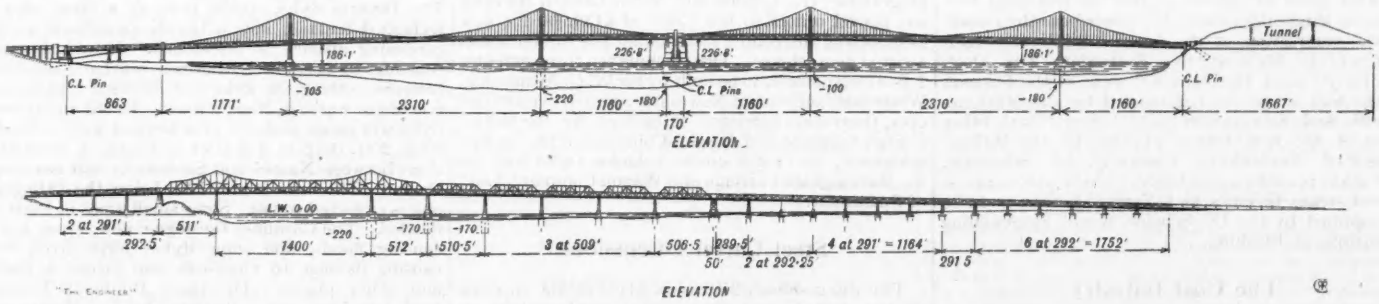
The building of the Golden Gate bridge has been undertaken as a public work and when completed, at an estimated cost of about £7,000,000, the structure will form a part of a great international highway from the Canadian border to South America. It is planned to complete the work in 1937, and the first cable for the "catwalk" used in spinning the main cables was strung in place last August. Foundation conditions are simple, since solid rock is reached relatively near the surface. In fact, the north or Marin County pier is founded at the water's edge and but little below the low-water line. The south or San Francisco pier, however, is 1125ft. from the shore, in water about 60ft. deep, with its base some 100ft below low water. Its construction was complicated by exposure of the site to storm waves, a swift tidal current, and a tidal range of about 9ft. In view of earthquake experiences along this coast, the steel towers are thoroughly anchored to an intricate steel framework embedded in the concrete piers, which extend about 40ft. above water. To protect the south pier from possible blows from shipping, especially in view of the prevalent fogs, it is surrounded by an elliptical wall or fender, 155ft. by 300ft. in plan, having a width of 30ft. and rising about 12ft. above water. It is thus impossible for a vessel to strike the pier or tower, as the fender is substantial enough to wreck a vessel driven against it.



NORTH TOWER OF GOLDEN GATE BRIDGE



THE GOLDEN GATE BRIDGE, SAN FRANCISCO



THE SAN FRANCISCO-OAKLAND BRIDGE

at each end. The steel towers, of cellular design, are about 700ft. high above the piers, or 746ft. above the low-water line. The north or Marin tower is shown in an engraving. At the north end, the cables enter an anchorage which forms a massive abutment for the stiffening trusses of the shore arm. At the south end, however, the cables are deflected downward at the abutment, in order to pass along under the viaduct approach to the anchorage. This is shown in the drawing.

There are only two cables, each 36¼in. in diameter, and composed of wires specified to have 220,000 lb. ultimate strength, 160,000 lb. yield point, and 4 per cent. elongation in 10in. Their deflection or sag is 475ft. from the saddles on the towers. The cables are 90ft. apart between centres, and have hangers or suspenders at intervals of 50ft. on the shore arms as well as on the main span. Two lines of stiffening trusses 25ft. deep are attached to the suspenders. Cross girders carried between these trusses at the level of the top chords support the longitudinal bearers and deck framing for a 60ft. roadway and two 11ft. walks. A clear headway of 220ft. at the middle of the span and 210ft. at the piers provides amply for the requirements of navigation. The bridge is designed for a live load of four 24-ton motor trucks and two 50-ton electric tramcars abreast.

A reference to a map will show that the City of San Francisco, with 650,000 inhabitants, is situated on a peninsula bounded on one side by the sea, and on the other by the great bay. On the further side of the bay there is a group of residential towns, the largest of which is Oakland, having a population of about 500,000. An average of about 50,000 persons cross the bay daily on large double-deck ferryboats to their work in the city. In addition, the ferries carry about five million cars and ten million other passengers annually. In 1929 a definite project for a municipal bridge was adopted.

In order not to encroach upon the anchorage areas for shipping in the bay, an indirect route for the bridge was selected. From San Francisco the bridge extends north-east to Yerba Buena Island—locally and colloquially known as Goat Island—and thence about east-north-east to Oakland. The island has a maximum width of about 3000ft., and its higher portion will be pierced by a tunnel 540ft. long, having a clear section 58ft. in height and 76ft. in width. This alignment divides the crossing into two distinct sections, having structures of entirely different types, as shown by the drawing. The total length between entrances will be about 8 miles.

For the west or San Francisco section, the principal part of the structure will be two duplicate and contiguous suspension bridges, meeting at a massive pier 170ft. long, which forms the anchorage for both spans. Each bridge has a main span of 2310ft., with anchor spans of 1160ft. There is a short approach at the city end, but the shore arm of the second suspension bridge extends to the island.

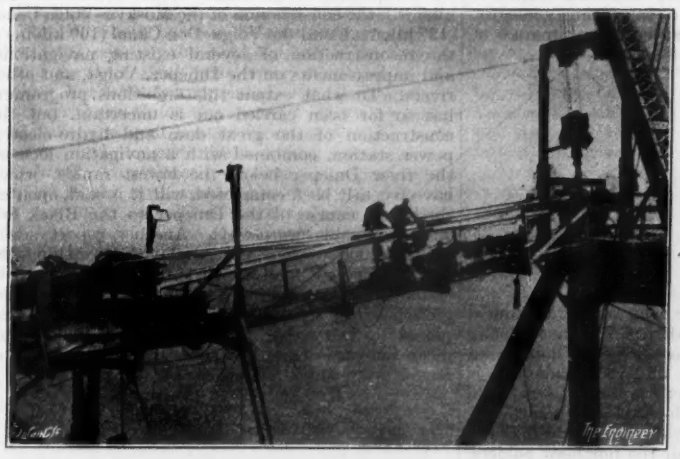
For the east or Oakland section, 11,700ft. in length, the main navigation channel is crossed by a through-truss cantilever bridge having a central span of 1140ft.—including a suspended span length of 576ft.—and anchor arms of 512ft. each. At the island end there is about 1200ft. of approach, with four deck-truss spans of 292ft. Beyond the cantilever bridge are five through-truss spans of 510ft. to 530ft., followed by about 4500ft. of deck-truss spans, 292ft. long and 1075ft. of plate girder viaduct. For navigation, there is a clear headway of 200ft. under the suspension spans, and 185ft. under the cantilever span.

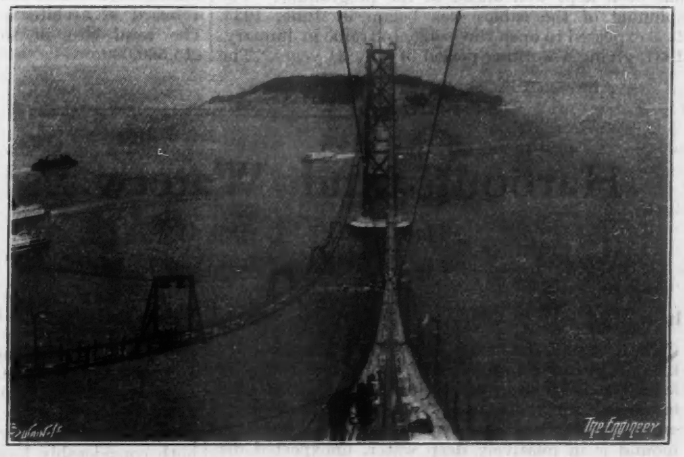
In the suspension spans there will be two cables, 28¾in. in diameter, spaced 66ft. apart between centres, and having a sag or deflection of 230ft. in the 2310ft. span. The towers are 560ft. high above low water, including 40ft. of masonry piers. The two parallel footwalks or catwalks used in spinning the cables are 10ft. wide. Instead of the usual plank floor for the catwalks, the floor or deck is of stiff steel wire welded netting of about 1½in. mesh, resting on and bolted to four lines of cables. This construction eliminates the risk of fire. Photographs reproduced show one of the suspension towers with the catwalks in place; the first suspension span, with the catwalks completed, and the island in the background; the catwalk cables being adjusted at the central anchorage pier; the placing of the cable saddle on one of the towers; and the erection of the anchor arm of the cantilever span on Yerba Buena Island.

Deep and difficult foundation work was required for many of the piers, while the constant traffic of ferryboats and steamers made it necessary to provide ample fender protection for both the construction operations and the completed piers. The bridge will be a double-deck structure throughout, with a 58ft. roadway on the upper deck reserved for six lanes of automobiles, while the lower deck will have a double-track electric railway and a 31ft. roadway for motor trucks.

Deep foundations for both the suspension and cantilever spans are important and interesting engineering features of this bridge. One of the suspension bridge piers reached a depth of 241·7ft. below low water, in water 115ft. deep, with swift and changing currents. The deepest pier for the cantilever span reached a depth of 242ft. below low water, in a somewhat shallower and quieter channel. In both cases open cellular steel caissons were used, with dredging wells. For sinking the caissons of the suspension bridge piers, however, the cylindrical wells were capped with steel domes for the use of compressed air for regulating the depth and buoyancy. The largest caisson was about 200ft. by 100ft. For such a size and depth this method of sinking was deemed preferable to the use of false bottoms to be removed after the caisson had been landed on the bottom.

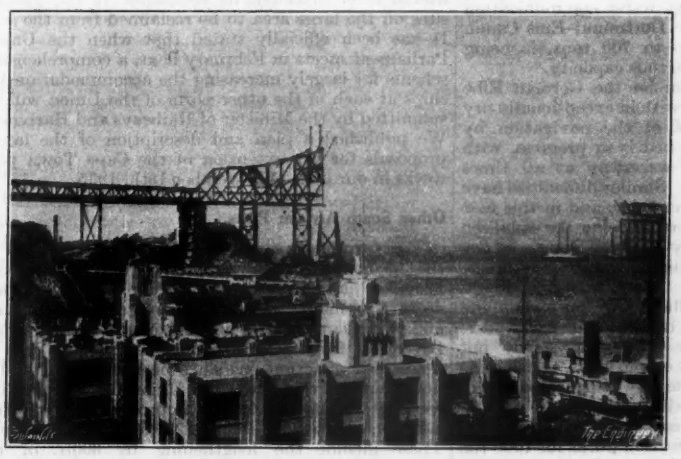
At the 242ft. depth for the cantilever span the water is about 50ft. deep, and the caisson is founded on a compact stratum of sand and gravel, rock being at the uneconomical depth of about 290ft. Here, also, the caissons were of cellular design, but made with rectangular wells. The largest caisson was 80ft. by 135ft. With the shallower water, the con-

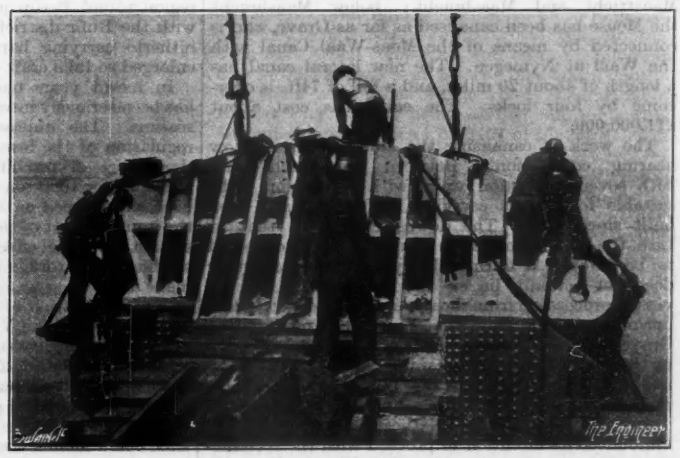




SAN FRANCISCO-OAKLAND BRIDGE—ADJUSTMENT OF CATWALK CABLES AND VIEW SHOWING CATWALKS AND YERBA BUENA ISLAND

TOWER AND CATWALKS OF SAN FRANCISCO-OAKLAND BRIDGE





SAN FRANCISCO-OAKLAND BRIDGE—ERECTION OF CANTILEVER SPAN AND PLACING OF CABLE SADDLE ON TOWER

ditions were more favourable to sinking by the use of false bottoms, and these were placed 5ft. above the cutting edge, thus permitting the caisson to penetrate and get an anchorage in the ground before the bottoms of the wells were removed.

Construction work was begun in July, 1933, and has been kept well ahead of the programme. The spinning of the cables was begun in June, 1935. It is expected to open the bridge to traffic in January, 1937, giving a working period of only 3½ years. The bridge is owned by the California State Toll Bridge Authority, and is being built under the direction of Mr. Charles H. Purcell, State Highway Engineer in the State Department of Public Works. Mr. Charles E. Andrews is bridge engineer, and Mr. Glenn B. Woodruff is engineer of design. For consulting advice there is a board of consulting engineers, a board of architects, and a consulting geologist. The total cost of the structure is estimated at £15,560,000.

Harbours and Waterways in 1935.

No. II.

(Concluded from page 7, January 3rd.)

Italy.

SOME trouble has been experienced at Genoa and Bari in connection with the rubble mounds which form the foundation of recently built vertical wall breakwaters at those ports. Although in all the cases where trouble has been experienced the top of the mound is in relatively deep water, unexpected disturbance and degradation of the large stones on the seaward face have occurred. The mounds are now being widened on the outer face of the breakwater and the seaward slope formed to a flatter gradient.

The extension of the eastern mole at Catania in Sicily, another breakwater of the vertical type (the wall being founded on a rubble mound at a depth of about 12·5 m. below water level), which was seriously damaged during a storm in February, 1930, and after partial reconstruction was completely overthrown during a storm of still greater violence that occurred in March, 1933, has now been replaced by a new structure. The vertical wall type has been abandoned and the new mole has been built on a line inside the foundations of the ruined breakwater in the form of a rubble mound brought up to water level, protected on its sea face by large concrete blocks and surmounted by a heavy mass concrete capping.

The first two deep-water piers to be constructed in the Bacino Mussolini at Genoa were brought into use in September. These works are at the extreme western end of the Genoa port works, which have, step by step, been extended in that direction since the early years of the present century. The building of another dry dock in the port of Genoa has been begun on a site parallel to the Molo Guardiano, near the entrance to the old harbour. The dock will have an internal length of 350 m., a bottom width of 40 m., and a depth of water over the principal entrance sill of 13 m. It will have two entrances, one for large vessels at the north end, facing the old harbour, and another for smaller vessels at the south end approached from the small Bacino Duca degli Abruzzi. The dock, which is expected to be ready by March, 1938, is estimated to cost 55,000,000 lire. The Schiavoni Quay, in the Bacino di San Marco at Venice, opposite San Giorgio, is being reconstructed and the berths deepened to allow of 30,000-ton passenger liners coming alongside.

Holland.

On September 16th, the Queen of Holland, in the presence of the Princess Juliana, formally opened the Juliana Canal, or, strictly speaking, the southern part of it, for one section, that between Born and Maasbracht, was brought into use in May, 1934. The Netherlands Government decided in 1921 to construct the Juliana Canal entirely in Dutch territory, and thereby solve the problem of improved navigation in the Meuse Valley below Maastricht, required to place the coal mines of southern Limburg in direct connection with other parts of Holland. The canal, which takes craft of 2000 tons capacity, forms a navigation lateral to the Meuse between Maastricht and Maasbracht; below Maasbracht the Meuse has been canalised as far as Grave, and is connected by means of the Maas-Waal Canal with the Waal at Nymegen. The new lateral canal has a length of about 20 miles, and a fall of 74ft. is overcome by four locks. The canal has cost about £11,000,000.

The work of canalising the Dutch Meuse is now nearing completion. Between Maasbracht and Lith seven regulation weirs with navigation locks suitable for vessels carrying 2000 tons have been built since 1925. The downstream weir, that at Lith, the building of which began in 1934, is expected to be completed during this year. The Lith weir does not actually lie on the main navigation, for vessels proceeding from the upper Meuse to Rotterdam normally diverge from the Meuse at a point above Grave, and, as we have already indicated, make use of the Maas-Waal canal, gaining access to the Waal at Nymegen. The weir at Lith comprises three openings of 38 m. each closed by roller gates.

In December the Netherlands Government announced its intention to proceed with the reclamation of the north-east polder of the Zuyder-Zee with the object of providing work for unemployed labour. This is the second of the four polders to be reclaimed in the Zuyder-Zee, the first, that of Wieringen, being the smallest. The north-east polder will have an area of about 118,000 acres and its reclamation is expected to occupy about six years and to cost 126 million florins. The south-west and south-east polders in the southern part of the Zuyder-Zee are both considerably larger than the northern polders.

European Inland Waterways.

We have made references to the extension and improvement of inland waterways now being made in Holland and Belgium. Works of at least equal importance are being carried out in other European countries. Germany is making progress with the Rhine-Main-Danube waterway, but relatively little improvement has been made in recent years, owing to lack of funds, on the Austrian section of the Danube.

The rivalry between German and Swiss interests, on the one hand, and French aspirations, on the other hand, as to the Rhine navigation between the Swiss frontier and Strasbourg does not seem to lessen. The French project for the construction of a great lateral canal between the frontier and Strasbourg seems at present to be in abeyance. The short section near Kembs is the only part of it which so far has been completed. The use of this enables craft navigating the Rhine to avoid the obstruction caused by the Istein rocks at times of low water. The German and Swiss alternative project, which is being proceeded with in opposition to the French scheme, contemplates the canalisation of the river and the removal of the Istein rock barrier, so that traffic could be continuous all through the year between Strasbourg-Kehl and Basle. German and Swiss collaboration has already achieved some improvements, and a channel having a depth of 2 m. at lowest water level has, it is claimed, been provided for a distance of about 49 miles. It is said that the whole of the river improvement works contemplated by Germany and Switzerland will be completed in 1941, and that vessels of 1200 to 1500 tons capacity will then be able to reach the port of Basle during the navigation season.

The improvement of the river Neckar for navigation is being effected by canalisation, and when the works now in hand are completed boats of 1200 tons will be able to reach Heilbronn. The Main also is in course of being canalised to permit 1500-ton vessels to reach Wurzburg.

The improvement for navigation of the upper Weser has hitherto been effected by regulation of the low-water bed of the river, supplemented during dry seasons by water drawn from storage reservoirs. The increased dimensions of craft using the waterway has resulted in consideration being given to the canalisation of the river and its further improvement by that means, so as to suit it to take the 1000-ton barges which will make use of the Mittelland Canal when that navigation is opened for traffic. The latter canal, between the Weser and the Elbe, is making progress, and according to present plans is to be opened to traffic in 1938. It will place the industrial region round Berlin in direct water communication with the Ruhr district. The Dortmund–Ems Canal, hitherto carrying barges up to 700 tons, is being enlarged to take craft of 1500 tons capacity.

In recent years navigation on the German Elbe has been seriously interfered with in exceptionally dry seasons. The improvement of the navigation by regulation of the low-water bed is in progress, with the object of providing a waterway at all times available for 1000-ton boats. Similar difficulties have been experienced on the river Oder, and in this case the improvement of the waterway below the canalised section is to be effected by drawing water in dry seasons from storage reservoirs which are now being made.

The canalisation of the Elbe in Czechoslovakia and of its tributary the Vltava, begun in the early years of the present century, is proceeding slowly but steadily. On the middle Elbe eleven weirs, each having a lock, have been built, five are being constructed, and twelve more are planned to improve the navigation in order to take 1000-ton craft. On the lower Elbe below Melnik the canalisation works for 1000-ton barges have now been finished, with the exception of the last barrage downstream, which bears the name of President Masaryk; this is approaching completion. The Czechoslovakian Oder, at present only navigable by relatively small craft, is also being canalised.

The second Five Years' Plan (1934–38) of the U.S.S.R. Government includes among other projects the completion of the Baltic White Sea Canal (227 kiloms.), the construction of the Moskva–Volga Canal (127 kiloms.), and the Volga–Don Canal (100 kiloms.), the reconstruction of several existing navigations, and improvements on the Dnieper, Volga, and other rivers. To what extent this ambitious programme has so far been carried out is uncertain, but the construction of the great dam and hydro-electric power station, combined with a navigation lock on the river Dnieper below the lowest rapids, which have recently been completed, will, it is said, open up the whole course of the Dnieper to the Black Sea as a navigable waterway. Another report states that 190,000 workers are employed in making the Moskva–Volga Canal, which is due to be opened to traffic in 1937. According to Dr. Timonoff, the completion of all the inland navigation works contemplated by the second Five Years' Plan, will result in an increase of the navigable waterway system of Russia from 84,000 kiloms. to 101,000 kiloms.

AFRICA.

Cape Town.

We referred a year ago to the appointment by the Union Government of South Africa of an Advisory Commission to inquire into the financial position of and the provision of additional accommodation in South African harbours. The report of this Commission was made public in July last, and contains a number of proposals regarding increased accommodation, for which Mr. Gerhard Nijhoff, the Dutch engineer and one of the Commissioners, appears to be chiefly responsible. The Nijhoff proposals for harbour extensions at Cape Town comprise certain improvements of the old Victoria Basin, which is at present insufficient to receive and berth the new liners building for the Union Castle Company, and the development of the large new basin on the south side of the harbour area, which has for over ten years been under construction at a somewhat leisurely pace. These proposals do not, however, appear to have met with the approval of the South African Railways and Harbours Administration, and in the meantime the works already embarked upon are being proceeded with. One of the principal works now in hand in the new basin is the provision of a deep-water quay, 900ft. in length, intended for the accommodation of the 25,000-ton mail boats which will be in commission this year. Since the publication of the Nijhoff report, another scheme of future extensions has been prepared and is now being investigated by the Administration, which would, if it is carried out, completely alter the original conception of the so-called new basin. This plan involves the removal of the random block mole which at present forms the southern limit of the basin and the extension of the basin still further in a southerly direction. The westward or landward part of the existing basin, as well as a large area of sea bed further south, would be reclaimed, and a quay wall built on a line facing the entrance, which would provide accommodation for five large ships. Concurrently with the lengthening of the basin in a north and south direction, the quay wall, 900ft. long on the east side of the basin now being built for large liners, would be extended in a southerly direction, so as to provide about 1700ft. of quayage. This alteration would entail the shifting of the entrance to the new basin further south by a corresponding amount. It is understood that the author of this latest scheme for Table Bay Harbour is Mr. J. F. Craig, who was appointed Harbour Advisory Engineer to the Union Government in 1934. The scheme also includes a large dry dock, 1150ft. long, at the southern end of the enlarged basin and a new fishery harbour still further south entirely independent of the basins used for overseas shipping. The estimated cost of these further extensions is £5,000,000, a considerable part of which expenditure would, it is expected, be recovered by the sale of sites on the large area to be reclaimed from the sea. It has been officially stated that when the Union Parliament meets in February next, a comprehensive scheme for largely increasing the accommodation for ships at each of the other ports of the Union will be submitted by the Minister of Railways and Harbours. We published a plan and description of the latest proposals for the extension of the Cape Town port works in our issue of November 15th, 1935.

Other South African Ports.

The turning basin which has been excavated in the harbour at East London at a cost of about £250,000 has now been completed. This work provides a swinging area, approximately 1000ft. wide and of the same length, near the mouth of the Buffalo River. A further extension of the turning area in a seaward direction has since been approved and is now being carried out. The Union Government has recently sanctioned other improvements at East London, on which about £250,000 will be spent. These include the lengthening by 600ft. of the south breakwater at the entrance to the river, and the provision of precooling facilities.

The Nijhoff report included recommendations dealing with the provision of additional berths and the deepening of existing berths at Durban. No decision appears to have been arrived at so far in regard to these major improvements, but some of the existing wharfs at Durban are now being lengthened.

The first section of the Algoa Bay harbour scheme at Port Elizabeth has now been virtually completed at a total cost of about £2,500,000. The harbour works in their final form were designed by Mr. Craig, the recently appointed Harbour Advisory Engineer to the Union Government. Since December 6th, 1934, the mail boats calling at Port Elizabeth have berthed alongside the new deep water quay on the North Arm instead of discharging cargo into lighters in the open roadstead. This quay (No. 1) has now been completed for a distance of 2700ft. The building of No. 2 Quay, projecting from the shore between the North Arm and the old South Jetty, has begun.

West Coast.

We referred a year ago to the new port which is being made by the French Colonial Administration at Pointe-Noire, in the French Congo, on an open sandy coast facing the Atlantic. Before a beginning was made with this work a small temporary harbour, dating from 1931, had been made near the site of the permanent works. Silting has given trouble in this temporary sheltered area, which provides accommodation for the floating plant required for constructing the much larger intended port and suction dredging has had to be resorted to to clear the sand accumulation. The rapid accumulation of sand here gives rise to some apprehension as to the probable effect of sand travel on the principal works. The French are also planning a new harbour at Abidjan, on the Ivory Coast, where it is proposed to provide deep water accommodation in a lagoon approached through an artificial cut made in the coastal belt of sand separating the lagoon from the sea. Before making a beginning with this somewhat bold and difficult work, the authorities have arranged for a series of scale model experiments to be made in the hydraulic laboratory at Delft in order to determine the probable effect of sand travel and the coastal currents.

Madagascar.

In Madagascar the French Colonial Administration has just completed the construction of one new harbour and is building another. The first, at Tamatave, on the East Coast, begun in 1929, is now in use ; it is situated on a sandy shore and comprises a protection mole about 1800 m. long, terminating in 20 m. of water. The mole, of rubble and concrete block mound construction, protects berthing jetties and quay walls, having a depth alongside them ranging from 4 m. to 10 m. at low water. The works already carried out form the first stage of a more comprehensive scheme of harbour construction contemplated for this port. Work at the new harbour of Majunga, on the West Coast of Madagascar, was begun in 1934 at the mouth of a river where a small harbour is to be formed by building two rubble and random block mound breakwaters similar to that at Tamatave at a cost of about 40 million francs.

Algiers.

The outer arm of the Mustapha jetty, a vertical wall breakwater which was destroyed in the great storm of February, 1934, is now being rebuilt in the form of a mound breakwater of the classic Marseilles type. The inner arm of the jetty, which was not irretrievably damaged by the storm, has been repaired, and a wide protective apron constructed on its seaward face which will, it is expected, suffice to safeguard the work until full protection is afforded to the Mustapha basin and jetty by the outer harbour breakwaters which are to be built as a part of the intended larger port works. We published a description of the failure of the breakwater at Algiers in our issue of September 13th, 1935.

THE EAST.

The maximum draught of water allowed to ships going through the Suez Canal has been increased as from January 1st, 1936, from 33ft. to 34ft.

Haifa.

Early in the year it was announced in Parliament that expenditure by the High Commissioner for Palestine on the preparation of plans for the further development of Haifa Harbour had been authorised. It is understood that these plans will include additions to the deep water quayage and storage accommodation in the port. A year ago, we recorded the completion of the oil pipe lines of the Iraq Petroleum Company, one section of which delivers oil at Haifa. On January 14th the King of Iraq inaugurated the pipe line system, the cost of which has been about £10,000,000, by starting the stream of oil from Kirkuk, the centre of the oilfield, on its journey to the sea. As a matter of fact, the first delivery of oil by the pipe line to Haifa had been made on October 14th, 1934, and about the same date oil was delivered at the other sea terminal at Tripolis.

Singapore.

Work still continues on the naval base at Singapore. The main contract placed with Sir John Jackson, Ltd., in 1929, was due for completion in September, 1935, and it is understood that practically all the works included in this original contract are now virtually complete. The large dry dock is due to be ready for use in September, 1937, and the Civil Lord of the Admiralty said in Parliament in March last that, provided the present rate of progress continued, the whole of the naval base should be ready towards the end of 1939. The harbour extensions at Singapore for the Singapore Harbour Board, a contract for which was placed in 1934 with Topham, Jones and Railton, Ltd., are still in progress. A quay wall 3300ft. long of concrete block work with a low-water depth of 33ft. in the berths, is the principal work included in the first section of the extension project. This, with the transit sheds and dredging connected with it, will cost upwards of £500,000, and is due to be completed in 1938.

The Yangtse Bar.

The Bar of the Yangtse and the proposals made for dredging a channel through it, have been mentioned on several occasions in our annual survey of port works. The powerful drag-suction dredger "Chien She," which has been built in Germany for the Whangpoo Conservancy Board for use on the bar, arrived at Shanghai in April, and has, we understand, already begun dredging a channel through the Fairy Flats. So far we have received no news of the performance of the dredger under working conditions, but we understand that the preliminary trials carried out off the German coast gave results which considerably exceeded contract requirements. It will be interesting to compare the performance of the German dredger with that of the very successful French dredger, "Pierre Lefort," as both were designed for dredging in the open sea under severe conditions of exposure.

Bangkok.

At the request of the Siamese Government, a committee of three harbour engineers was nominated by the League of Nations in 1933 to report on the question of improvement of the approaches to the port of Bangkok and in the facilities at the port. The committee comprised Mr. A. E. Coode (English), Mr. Gerhard Nijhoff (Dutch), and Monsieur Watier (French) The local investigation was made by Mr. Nijhoff, and the report of the commission was issued recently. The port of Bangkok is about 35 kiloms. from the mouth of the river, where there is a bar, which at high water limits the draught of vessels crossing it to 12½ft. to 14½ft., according to the season of the year. Above the bar the river depths are adequate for ocean-going shipping. The report of the committee recommends the dredging of a channel through the bar to ensure the passage at any high water of vessels with a draught of 23ft. in the first instance, to be increased later on to 28ft. Other improvements recommended are the construction of quays along the river banks. The capital cost of the complete project is estimated at £1,818,000, of which about one-half would be required for the first stage of the works.

Japan.

The recently completed quay wall in the Umemachi Basin, Osaka, is of special interest because it has been built on foundations of Oregon pine piles, about 34 m. long, driven through mud to a resistant stratum reached at depths of about 35 m. below low water level. The construction of new quay walls on poor foundations, comparable with that met with at Osaka, is also in progress at the present time at Yokohama and Kobe, where extensions of port works are being carried out on a large scale.

AMERICA.

Florida Ship Canal.

The project of a ship canal across the Florida peninsula is an old one which has been revived in connection with President Roosevelt's schemes of relief works. The Government of the U.S.A. in September appropriated 5,000,000 dollars for the commencement of the work of cutting this canal, the total cost of which is estimated to be about £30,000,000. The canal will extend from Jacksonville on the Atlantic coast to Port Inglis on the Gulf of Mexico, a distance of nearly 200 miles, including the deep water channels at each end. The canal proper will be about 100 miles long, with a bottom width of 250ft. and a depth of water of 33ft. A portion of the navigation would be by way of the St. John's River, which would be improved and widened. It is stated that the whole project involves about 570 million cubic yards of excavation. The canal, if its complete construction should be realised, would shorten the time of sea transit from the eastern seaboard to Gulf ports by about 2½ days. Although tolls would be charged, it is not expected that the revenue would be sufficient to pay for more than the maintenance cost.

Cape Cod Canal.

The modernisation of the Cape Cod Canal, at a cost of more than 31,000,000 dollars, is now being carried out. The canal was first opened for traffic in 1914, and connects Cape Cod Bay on the north with Buzzards Bay, on the south of the Cape Cod peninsula. Its use shortens the sea passage from New York to Boston and other New England ports by about 165 miles, and ships making use of it avoid the exposed open-sea route round Nantucket Shoals. Ever since the opening of the waterway trouble has been experienced as a result of the strong currents in the canal, due to differences of tidal range and times of high water at the two sea terminals. Bank erosion and frequent slips have also been a continuous source of difficulties. There are no locks and the current through the canal at times reaches a rate of over 4 knots, which, in such a narrow waterway, having a bottom width of 125ft. or less, constitutes a danger to navigation. Of the alternative proposals for dealing with these difficulties, namely, the construction of locks and widening and deepening, the latter was adopted. In 1928 the canal was taken over by the Federal Government from the company that constructed it, and is now toll-free and maintained and operated by the Chief-of-Engineers of the U.S. Army. Traffic has increased very considerably since 1928, and the virtual reconstruction of the waterway that is now being carried out will provide a channel having a low water depth of 32ft. and a width of 540ft. The approach channel through Buzzards Bay is to be widened and deepened proportionally. The three existing bridges over the canal have been replaced by new bridges of increased span and vertical clearance. We recently published a description of the Cape Cod Canal and of the works now in progress for its improvement.†

Chesapeake and Delaware Ship Canal.

Another small isthmian canal in the U.S.A., the Chesapeake and Delaware Canal, is also being modernised and reconstructed. This waterway is 14 miles long and connects the head waters of Delaware Bay with the upper end of Chesapeake Bay. It had a low water depth of 12ft. and a minimum bottom width of 90ft. These dimensions are now being increased to minima of 25ft. and 250ft. respectively.

The Intracoastal Waterway.

One of the most important groups of works included in the National Waterway Plan of the Federal Government is the Atlantic Intracoastal Waterway, comprising the interconnection of the rivers discharging into the Atlantic Ocean south of the Hudson River by a through waterway parallel with the coast, but sheltered from the ocean. The Government has undertaken the making of a navigable waterway extending from north of Philadelphia to Southern Florida, making connection with the mouths of all the rivers. It is made possible by the existence of the system of bays, sounds, and sheltered lagoons which extends along the Atlantic Coast. These natural waterways have been connected and deepened when necessary, and the through waterway is now completed from Philadelphia to North Carolina. Long continuous stretches further south have also been finished and are in use, and work is in progress on the remainder. It is expected that the through channel will be completed in the summer of this year. For the most part the waterway will have a navigable depth of 12ft., but some sections are only 7ft. deep.

Missouri and Mississippi Rivers.

The improvement of the Missouri, effected by means of regulation works, has now been completed for the first 400 miles up to Kansas City, giving a navigable channel with a minimum depth of 6ft. Irrigation in the arid North-West has reduced the minimum river flow so considerably that a huge storage reservoir having a capacity of 20 millions of acre-feet is now being built at Fort Peck, Montana. This work when completed, will ensure a minimum, flow of 35,000 cusecs. at Kansas City and a depth of 9ft. The regulation of the river Missouri above Kansas City is now being carried out for another 400 miles to Sioux City. No part of the Missouri has, so far, been canalised.

The project for canalising the Upper Mississippi (above the mouth of the Missouri) was begun in 1930, the scheme including twenty-seven locks and dams spread over a distance of 650 miles from Minneapolis down to Alton (Illinois). The minimum navigable depth will be 9ft. Below Alton the same depth will be secured by regulation.

In connection with the vast works and river improvements now being carried out by the Federal Government in the U.S.A., Colonel T. H. Jackson, of the Corps of Engineers, U.S.A. Army, gave, in a paper presented at the International Congress of Navigation at Brussels, in October, some cost figures which illustrate the magnitude of the expenditure involved. Up to December, 1933, there had been constructed on

† THE ENGINEER, Oct. 11th and 18th, 1935.

the Mississippi River and its tributary, the Missouri River, approximately 930 miles of bank protection at a cost of about 100,000,000 dollars; of this length about 700 miles are still effective. The cost of maintenance has involved an expenditure of about 46,000,000 dollars over and above the capital cost.

The Lower Mississippi, below the mouth of the Ohio, is now being improved for navigation by regulation and dredging in the open river, and for control of floods by means of levees with diversions. Prior to 1928 about 200 miles of bank protection had been constructed to safeguard the levee system at a cost of about 46,000,000 dollars. In 1928 Congress authorised bank protection work estimated to cost 80,000,000 dollars, and since that date 71 miles of protection has been carried out at a cost of 18,500,000 dollars. The first cost per mile of bank protection in the Lower Mississippi has, since 1918, averaged 310,000 dollars. In the Middle Mississippi above the mouth of the Ohio the average cost per mile since 1929 has been 120,000 dollars.

The newer types of dredger designed for the removal of sand bars on the Mississippi and Missouri rivers are capable of removing 3000 to 4000 cubic yards per pumping hour when working in medium sand as found between St. Louis and Cairo. Pipe line cutter suction dredgers of large size and high power are being increasingly employed on the rivers and in the harbours of the United States. The most powerful dredger of this type hitherto built is equipped with 3500 b.h.p. steam turbines driving the pumps and cutters operated at 800 b.h.p. The largest Diesel-electric dredger in use in the U.S.A. has a 3000 b.h.p. motor driving the pump. A cutter dredger plant, said to be the most powerful that has yet been built, is now being made for the Corps of Engineers, U.S.A. Army, for use on the construction in the Missouri River of an earth dam about 250ft. high. The dam, which is intended to form a storage reservoir for river regulation, will be built by electric dredgers feeding 28in. diameter pipe lines. The total brake horse-power required for each dredging pump and four booster pumps on its discharge pipe will be 12,500, and the cutter motors on each unit are 700 b.h.p. Each dredger is estimated to have an output of 800,000 cubic yards per month, or about 1500 cubic yards per hour. Power is to be obtained from a hydro-electric plant in the vicinity.

Non-cutter suction dredgers of the so-called "dust-pan" type are being increasingly used on the Mississippi and Missouri rivers for rapidly dredging through shoals. Some of these craft have pumps of 1500 i.h.p. and 34in. diameter discharge pipes. A maximum output of 6000 cubic yards per pumping hour discharged through 700ft. of pipe line has been obtained.

The Ohio River.

The two last of the great series of dams and navigation locks which have been constructed on the Ohio River in accordance with the project adopted by Congress in 1910 are now nearing completion. Strictly speaking, these do not form a part of the 1910 project, which comprised the building of forty-nine movable dams and the provision of a minimum navigable depth of 9ft. throughout 981 miles of canalised waterway. The original project was completed in 1929. About that time two of the original movable dams were replaced by fixed dams, and now two more dams of the fixed type are being built, one below Pittsburg and the other at Gallipolis, below the junction of the Kanawha River with the Ohio, each of which will replace three movable dams. The magnitude of the Ohio waterborne traffic is evidenced by the fact that in a normal year (1930) the total ton-mileage was 1474 millions.

The examples we have mentioned of river improvement work now being carried out in the U.S.A. form only a part of the vast National Waterway Plan undertaken by the Federal authorities.

Canada.

The Canadian Government early in the year voted the sum of 3,500,000 dollars to be spent on the deepening of Montreal Harbour and other improvements in the port. Extensions are to be made to several of the piers, including the Laurier Pier, the depth of water to be provided alongside in all cases being 35ft. at low water. Work on the Laurier and Sutherland piers has already begun. A large part of the harbour area is now in course of being deepened to a minimum of 35ft. at lowest low water.

A contract has been placed for the reconstruction of several quays at St. John, New Brunswick, at a cost of about 2½ million dollars. Reinforced concrete cylinders surrounding timber pile clusters supporting a reinforced concrete deck are to be used for the substructures, which are expected to be completed in 1937. The present contract does not include the sheds and other equipment of the wharves.

Electrical Engineering in 1935.

No. II.

(*Concluded from page 28, January 3rd.*)

THE British Electrical and Allied Industries Research Association issued during 1935 eighty-two new reports. Continued technical and financial support made important developments possible in several directions, although funds available did not enable the Council to undertake all the researches the industry desired. Equipment was purchased for field work on surge phenomena and on circuit breaking. Researches on radio interference, high-voltage measurement, creep of metals, and on dielectrics were continued with good results. Among researches completed was that on thermal transference coefficients in steam condensers and other plant. Despite expansion of activities, the Association had before it at the beginning of the year further proposals for researches which would have needed an additional £10,000 to finance. Had the industry been willing to subscribe £5000, the Government was prepared to find the remainder. There is, in fact, at least £8000 of Government money available if the industry will provide the amount needed to enable the Association to claim it, but it is feared that this offer will not be long continued.

The new auxiliary laboratory at Perivale, illustrated on this page, was opened by the Duke of Kent in October. It is equipped with much useful experimental apparatus, which promises to provide a permanent and valuable asset to the Association. Researches on electric control apparatus, originally conducted at Newcastle and later at Willesden, will in future be carried out in this new laboratory, which is also being used for many other kinds of investigation.

All the laboratories belonging to the large electrical firms, such as the G.E.C., B.T.H., and the Metropolitan-Vickers Electrical Company, appear to have been busy. A section of the G.E.C. laboratories was extended and specially equipped for television development. Two high definition television transmitters were installed during the summer, one for radio transmissions and the other for wire transmissions. Work on television receivers covered the theoretical design of circuits and the evolution of production designs in co-operation with the company's telephone works. The development of cathode ray tubes for high definition television has been in progress in these laboratories for a considerable time. Other G.E.C. research work related to improvements in cold cathode high-tension discharge tubes, mercury flood-lighting tubes, photometry, street lighting, thermal problems in lighting fittings, short-wave valves, radio interference, the design of loud speakers, photo cells, heating appliances, &c. A new high power testing laboratory at Witton is one of the most complete of its kind, and switchgear units may be tested there when subjected to short circuits up to two million kVA at any commercial voltage.

New and improved magnetic steels were developed in the research department of the Metropolitan-Vickers Electrical Company, Ltd. Thermionic devices applied to the control of welding equipment were investigated with promising results. An investigation into the design of resilient supports for preventing the transmission of vibration and hence noise from machinery mounted thereon yielded valuable commercial results. Research on the creep of metals was continued and particular attention was paid to creep under compound stress. Improvements were made in steels for use at high pressures. Development of continuously evacuated demountable valves was continued and valves capable of dealing with large power at very short wave lengths, such as are required for television transmitting stations, were produced.

In the B.T.H. research laboratories particular attention was paid to electric discharge lamps and vacuum tubes. Research on thyratrons, rectifiers, and photo-electric cells was continued, and investigations of the characteristics and properties of cathode ray tubes for television purposes were undertaken. The chemical and metallurgical section carried out extensive investigations on the properties of various materials and researches on synthetic resins, varnishes, and moulding powders.

Wireless Work.

Research work of wireless engineers concerned with broadcasting was devoted, on the transmission side, mainly to improving modulating systems and reducing the side band spectrum of transmitters without detriment to quality. Experiments indicate that a solution to the problem may be provided by several methods now receiving consideration. The series modulating system adopted by the Marconi Company was put into service on several high-power transmitters, and they are behaving satisfactorily. Problems connected with the design of high-power transformers to produce constant outputs over wide frequency bands led to extensive experimental investigations. An increasing demand was experienced for higher power short-wave transmitters, capable of serving for telegraphy, commercial telephony, or international broadcasting. Single-unit valves capable of handling an input of 70 to 80 kW on telegraphy were developed for these sets. Small power sets of from 2 to 3 kW output are being installed in various countries for inland communication networks.

High definition television on wave lengths between 6 m. and 8 m. led to a demand for high-power ultra-short wave sets, capable of reproducing the frequency band necessary for high definition pictures. While a year ago the peak power available was 8 to 9 kW and the band width $\pm 0{\cdot}5$ megacycles, the former has now been increased to 16 and 18 kW and the latter to $\pm 1{\cdot}5$ megacycles. The outstanding event in the field of television was the publication on January 31st of the Television Committee's report, giving the full recommendations concerning the establishment of a high definition service. At a single transmitting station the systems of Baird Television, Ltd., and Marconi E.M.I. Television, Ltd., are to be given an extended trial under strictly comparable conditions by using them alternatively, and in the light of the experience gained the Advisory Committee will proceed with the planning of additional stations until a complete network has been established.

General-purpose wireless transmitters, including all military and portable combined transmitter and receiving sets, were improved in various ways. The growing demand for more and more quantitative performance specifications led to more elaborate measurement work, with a consequent favourable reaction on design. Controls were simplified and frequency stability, carrier noise level, and audio frequency response improved. As in other spheres of electrical Remote control continued to make headway.

"Tolerance" limits on marine transmitters are being reduced below those demanded by the Madrid Convention. Many questions relating to former

E.R.A. RESEARCH LABORATORY AT PERIVALE

administrative control of frequency allocations were dealt with, particularly in the case of telephone transmitters using the 109-200 metre wave band, and general technical conditions governing marine transmission were studied. The reflection coefficients of the ionosphere were fully investigated. Increased knowledge of the structure of the ionosphere was obtained and a more accurate determination of attenuation over great distances made possible.

Besides being a valuable tool for use when investigating the properties of the ionosphere impulse technique has been applied under practical conditions to direction-finding. The ground ray can be separated by an interval of time from the direct ray, and accurate direction-finding work free from the polarisation error caused by high-angle reflected waves has been made possible. For aircraft navigation on which the range of the direct ray is considerable, the system is particularly advantageous. Research work confirmed the theoretical expectation that a system of spaced aerials is substantially free from polarisation error. A fundamental research on the directional properties of short waves carried out with the aid of this spaced-frame system, led to the possibility of utilising in certain cases the waves between 14 m. and 100 m., which were previously considered to be useless for directional and navigation purposes. Continued research also led to a better understanding of the problems associated with the Adcock direction-finding system. In this system two channels, operating on a single Adcock aerial and separated by 8000 cycles, work with an instrumental error of ±2 deg.

Valves of much lower inter-electrode capacity were developed to meet the demands of designers of receiver circuits. By confining the electron stream to a narrow beam, it has been possible to reduce the capacity considerably. Apart from this, the new valves have a very high impedance. They are adaptable to special circuits and have greatly assisted experimental work. Feed back methods for securing distortionless amplification, high selectivity, and for frequency response correction were investigated with promising results.

Post Office Wireless Work.

Short-wave telephone communication was established between this country and Japan in March. In August communication was made possible by the same method with Iceland, whilst tests now in progress relate to a link with Shanghai. Although really beyond the scope of this article, it may be recorded that at the end of 1934 a wireless telephone link was put into service between England and North Ireland. There are 6 two-way circuits with 12 wave lengths between 4 and 6 metres and 10 watt transmitters with simple directive aerials are used. Services established between Lerwick and Whalsey and between Ballycastle and Rathlin Island employ equipments which may be used for either sending or receiving. To reduce maintenance costs the receiver is switched on by a time switch for one minute every hour, and if the distant transmitter is energised during this time it indicates a call. Whilst the Scottish service is worked on an ultra-short wavelength, on account of the land contour, the Irish service is operated on a wavelength of about 70 m. A regional scheme with allocated wavelengths for inter-ship and ship-shore communication was established in the North Sea.

Efforts to reduce interference with broadcast reception were continued by a trained staff throughout the country. Public exhibitions were held and co-operative action taken with trollybus undertakings. International conferences of experts considered the measurement and desirable limits of interfering voltages, and the Committee of the British Standards Institution published B.S. No. 613 Specification entitled "Components for Radio Interference Suppression Devices."

E. R. A. RESEARCH LABORATORY AT PERIVALE

High Pressure Developments.

Operation of the grid and overhead lines generally led to new developments. The growth of interconnections at 132 kV and at lower voltages has indicated, as in America, the necessity for the speedy interruption of faults to prevent widespread disturbance. On overhead systems the majority of faults are of a transitory character, and immediate reclosure of circuit breakers is often desirable. By improved designs of arc-control devices, some utilising self-generated gas pressure alone, and others that pressure augmented by external means, the B.T.H. Company has obtained operating speeds in the neighbourhood of 6 cycles and less. Impulse voltage testing with particular reference to protective measures against lightning and other transient voltages was investigated in several quarters. With the B.T.H. lightning generator at Willesden tests were regularly made at pressures up to 1 million volts on the various standard waves. The generator is the largest of its kind in the country.

Like the B.T.H. Company the Metropolitan-Vickers Electrical Company paid attention to oil circuit breaker testing under short-circuit conditions and to arc control under these conditions. A new switchgear-testing plant, owned jointly by the B.T.H. Company, Ferguson Pailin, Ltd., and the Metropolitan-Vickers Electrical Company, was put into service at Trafford Park, Manchester.

Increased activity in industrial circles resulted in an increased call for industrial switchgear. Additional business of this kind also arose from the Central Electricity Board's policy of increasing the capacity of many selected stations which have consequently needed control board extensions. Other stations not immediately affected by the Board's policy were also equipped with new control boards. As in the past, continued expansion of generating plant called for the reconstruction of much existing switchgear to make it suitable for higher breaking capacities. There was also a large demand for new switchgear for service both in this country and abroad. For rural distribution schemes much equipment was produced and new devices, such as improved reclose circuit breakers, developed.

Transport.

Despite the present extensive use of overhead lines in this country, the cable manufacturers are not by any means short of work. One firm, namely, British Insulated Cables, Ltd., was compelled to duplicate its impregnating plant for super tension cables. Incidentally, the company received a fair share of foreign transmission line work, including the construction of the 85-mile, 66-kV line from Erode to Trichinopoly, completed for the Madras Government. Another Indian power line, 55 miles long, was completed from Sumera to Chandausi. B.I. railway contracts include one for Warsaw, where overhead equipment and rail bonding work is being carried out on 155 miles of track on behalf of the contractors' committee for the electrification of Polish railways. Another job is in Brazil, where the firm is similarly equipping 112 miles of track on the suburban section of the Central Railway of Brazil at Rio de Janeiro for the Metropolitan-Vickers Electrical Company, which is also electrifying the main line from Rio to Barro do Pirahy, at the top of the Serra, a distance of 108 kiloms. from Rio, and the branch line to Santa Cruz, a distance of 55 kiloms. from Rio, all on the 3000-volt D.C. system. For the South African Government, the Metrovick Company is supplying twenty-five 1200 h.p., 3000-volt locomotives, and six 3000-volt locomotives for Poland. The extension contract for the Copenhagen suburban electrification

ENGLISH ELECTRIC 900 KW STEEL TANK RECTIFIER AT BRADFORD

G.E.C. 1000 KW MERCURY ARC RECTIFIER EQUIPMENT AT POPLAR

of the Danish State Railways was completed by the English Electric Company, which also concluded an agreement with the Southern Railway for the supply of electric rolling stock for the next ten years. The extension of the Southern Railway main line scheme to Eastbourne and Hastings was opened in July. Several new schemes of electrification were investigated by the G.E.C., which is building an entirely new type of equipment for experimental work on tube railways.

The Crompton-West traction organisation, which covers the combined traction activities of Crompton Parkinson, Ltd., of Chelmsford, and Allen West, of Brighton, received orders from the home railways for electric traction equipments valued at approximately £200,000. Equipments are being supplied for the Tyneside lines of the L.N.E.R., which are to be modernised and extended. The order covers sixty-four articulated two-car units, equipped with two motors, and a number of four-motor vans and coaches, the contract being for the supply and erection of the motors, control gear, and heating and lighting equipment. In addition, the organisation has in hand orders for the motors, control gear, and main and auxiliary generators for the oil-electric shunting locomotives for the L.M.S. Railway placed by Sir W. G. Armstrong-Whitworth and Co. (Engineers), Ltd., and home and overseas contracts for tramway and trollybus traction equipments.

Trollybus progress was more marked than in any previous year. The introduction on a large scale of these vehicles by the London Passenger Transport Board represents the first stage in the replacement of trams by trollybuses in London. For the scheme the G.E.C. began delivery of 101 vehicles designed for regenerative control. Besides securing orders for a good proportion of the equipments for the scheme, the English Electric Company is also supplying trollybuses to the Bradford, Newcastle, Portsmouth, Darlington, and Southend Corporations, and to the Johannesburg Municipality. Among other firms turning out these vehicles to meet present-day demands are the Brush Electrical Engineering Company and Ransomes, Sims and Jefferies.

Rectification.

Mercury arc rectifier development during recent years has been one of the most interesting features of electrical engineering. Many of these rectifiers have been put into service in this country and abroad, and two recent examples are illustrated herewith. The former is a 900-kW, 556-volt (D.C.) steel tank English Electric rectifier installed in a traction sub-station of the Bradford Corporation, and the latter a G.E.C. 1000-kW rectifier converting from 6600 volts three-phase to 460/560 volts at the Farm Gate sub-station, Poplar. The latest development, it seems, is the metal-cased pumpless type of rectifier as being supplied by the G.E.C. to the London Passenger Transport Board. An additional B.T.H. 1500-kW steel tank mercury arc rectifier ordered by that body is being installed in the Holloway-road sub-station, originally equipped with two such units, forming part of the large contract carried out by the B.T.H. Company in connection with the extension of the Piccadilly Railway from Finsbury Park to Cockfosters. Three B.T.H. 2000-kW rectifiers with all switch and control gear are nearing completion to take care of increased load at the Tower Hill sub-station supplying the District and Metropolitan Railways. Rectifiers with a total capacity of 4500 kW are under construction in the B.T.H. works for the sub-stations at Hendon and Burnt Oak, on the Hampstead line between Golders Green and Edgware. Three 500-kW, 600-volt B.T.H. rectifiers were supplied during the year to Associated General Industries, Ltd., for the tramway system of Brisbane, Australia. But perhaps the most interesting B.T.H. job from a technical point of view is the construction of twenty 3000-volt mercury arc rectifiers for the South African Railways. This is said to be the largest single contract ever placed for rectifiers for inverted operation, which is essential for regenerative railways. The English Electric Company is supplying rectifiers to the Stafford Water Board, the Birkenhead Corporation, the Bristol Corporation Tramways, and Kingston-upon-Hull.

Miscellaneous.

Perhaps the most noteworthy development in the field of electric welding was the greatly extended use of A.C. Progress in the manufacture of covered electrodes and in the design of A.C. welding apparatus is said to have resulted in the production of A.C. welds which in many cases are indistinguishable from those made with D.C. Instruments and relays and especially house service meters were modified and improved. Ferranti, Ltd., introduced a meter in which a self-starting synchronous motor provides the constant speed necessary for operating the fixed charge collecting unit which forms part of the Ferranti two-part tariff prepayment meter.

Voltage regulators of the moving coil, induction, and other types continued to find a ready market, and on-load tap-changing transformers for relatively small outputs were developed by the Hackbridge and Metropolitan-Vickers Electrical Companies. Since the completion of the grid the demand for very large transformers has naturally diminished, but the call for relatively small distribution transformers is distinctly on the increase, and units with on-load tap-changing equipment are sometimes used for feeder regulation, although it is more common to employ a voltage regulator such as the Ferranti moving coil regulator, which, as the result of improvements made during the past twelve months, has been made more efficient and robust.

That street lighting in various parts of this country has been greatly improved by the use of electric discharge lamps is common knowledge, but it is not so well recognised that the manufacturers of these lamps are ever striving to secure still better results. Apart from work on the lamps themselves, considerable attention was paid during the year to problems connected with reflectivity on road surfaces, a matter of no small importance in connection with the avoidance of street accidents.

Water Supply & Sanitary Engineering in 1935

No. II.

(*Concluded from page 26, January 3rd.*)

Durham.—The Burnhope reservoir of the County Water Board has been practically finished. At the present time water to a depth of about 70ft. has been impounded out of a total depth of 117ft. The building of the dam and other works has cost in the neighbourhood of one million pounds, and the reservoir will hold 14,000 million gallons of water when full. Besides to the Durham Board water will be supplied to the Sunderland and South Shields Water Company. The consulting engineers for the work are Messrs. T. and C. Hawksley, of Westminster.

Glasgow.—To improve the supply of water to the King's Park area, a pumping station has been erected in King's Park-road. Two pumping sets have been installed and provision has been made for two additional sets. Each set comprises a two-stage, horizontal split casing, 750 gallons per minute, centrifugal pump, driven through a flexible pin type coupling by a three-phase, 440-volt, 50-cycle, squirrel-cage induction motor, supplied by the Harland Engineering Company, Ltd. The starters are of the auto-transformer type. The building also contains a small sub-station to transform the electrical energy supply from 6600 volts. Main and distributing pipes were extended during the year by 24,019 yards, and 5093 yards of pipe were relaid, making a total of 29,112 yards, or approximately 16½ miles. In addition, approximately 8½ miles of piping were scraped. The largest pipe laid was a 24in. main in Shieldhall-road, for a length of 1½ miles, which will ultimately carry the supply to the Burgh of Renfrew.

Following upon a joint report by the City Engineer and Mr. Alexander Hunter, general manager of the Sewage Department, on the method of treatment to be adopted when the Dalmarnock sewage works are modernised, the Corporation has agreed to the installation of an experimental "Simplex" activated sludge plant to deal with an average daily volume of 500,000 gallons. This plant, when erected, will be kept in operation for twelve months before a report on its capabilities and suitability is made.

Lancaster.—The Langthwaite reservoir was formally opened in October. It is part of a scheme for three reservoirs storing water for the supply of Lancaster, Morecambe and Heysham, and the rural districts of Lancaster and Lunesdale. The area of the water surface will be about 31 acres when the reservoir is full, and the maximum depth 40ft., giving a total storage capacity of 190 million gallons. Messrs. James Mansergh and Sons are the consulting engineers. The reservoir consists of a main embankment for about one-third of its circumference, and a small embankment round the remainder running into the natural hillsides. The main embankment has a concrete core wall and is about 1500ft. in length.

Leeds.—The whole of the sewage of the city, excepting that of a small area on the south-western boundary (which is served by the Rodley Works), is disposed of at the main sewage purification works situated on the new sewage disposal estate at Thorpe Stapleton, about three miles from the centre of the city to the south-east. During the year the installation of the new sludge-pressing machinery in the new sludge press house was completed and the plant is now in operation. The sludge storage tanks were finished. The first instalment of the scheme is now complete, and the plant is functioning as a whole, the turn-over from the old plant to the new having been accomplished.

Liverpool.—In 1934 the Corporation decided to proceed with the completion of the third line of the Vyrnwy Aqueduct, including additional filters, booster scheme, new shafts and tunnel at the river Mersey crossing, and balancing reservoirs. The third line is 42in. internal diameter, and of lap-welded steel pipes, lined and sheathed with bitumen. The following sections were brought into commission during the year 1935:—Cuerdley to Prescot, a length of approximately 6½ miles; Malpas to Ashton's Cross, a length of approximately 1·6 miles; Brown Moss to river Weaver, a length of approximately 2 miles. The total cost of these sections, including self-acting valves and all other incidental works, was £177,000.

The first stage of the booster scheme at Oswestry filter beds was brought into use in 1934, and the second stage in 1935. The plant comprises two sets of turbines and pumps, each set consisting of a turbine driven by the high-pressure unfiltered water from Llanforda reservoir, situated at the termination of the unfiltered water aqueduct from Lake Vyrnwy. Each turbine is direct coupled to a centrifugal pump which picks up the filtered water from the beds and delivers it at an increased pressure to the respective existing main on the next section of the aqueduct to Liverpool. The pumps are of 300 h.p. and 218 h.p., and boost the delivery by 5·5 and 3·7 million gallons per day respectively.

The existing supply to Liverpool from Lake Vyrnwy is taken from the lake at the straining tower through fine mesh copper gauze strainers, and through the Hirnant tunnel to the Hirnant valley, where the pipe lines commence. The alternative draw-off will be taken from the North-East discharge tunnel in the dam, along the Aber conduit, now in course of construction, and thence through the Aber tunnel, completed in 1934, to two open circular strainers at Hirnant, which have already been constructed. The strainers have a common self-acting valve chamber, which is connected to each of the three existing mains. The Aber conduit is approximately 1·4 miles in length, and will consist of bitumen-lined steel pipes, 54in. internal diameter. Work on the conduit was commenced at the end of July, 1935, and it is anticipated that it will be completed early in 1936. The estimated cost of the whole of the work is £113,000.

In order to obtain the required data for the construction of the second tunnel under the river Mersey, it was necessary to drive a series of exploratory borings through soft ground on the river banks and in the river bed. The first bore-holes were begun at the beginning of February, 1935, the last one being completed during the first week of July. Four were on the North bank, two on the South bank, and nine in the river bed, the depths varying from 93ft. to 180ft.

Manchester.—The length of distribution mains was increased during the past twelve months by a record amount. Work (resumed in 1934) on the Haweswater headworks was pushed forward, and the foundations for the dam are now ready for concreting to begin. The tunnels and cut-and-cover work to 11½ miles from the outlet well at Haweswater were completed, and a 30in. steel main, 2½ miles in length, linking the present end of the Haweswater aqueduct with the Thirlmere aqueduct, is being laid.

In connection with the extensions to the Davyhulme sewage works, which, as mentioned earlier, were opened officially in May, a contract has been let for the constructional works of the new sludge digestion plant at an estimated cost of £17,620. A 3ft. 9in. diameter sewer, consisting of cast iron segments lined with concrete and brick, at an average depth of 90ft., was almost completed at an estimated cost of £47,000. A number of local sewers were constructed.

Nottingham.—This city has under construction a main drainage scheme estimated to cost about £1,000,000. The construction of the main sewer to the new pumping station at Sneinton was completed early in this year, and the pumping station has been put into partial operation. The gravitation trunk sewer through the city, approximately 3½ miles long, mainly in tunnel, was also completed. The Forest Valley storm culvert has been nearly completed. The sewage disposal works at Stoke Bardolph are nearing completion. The works carried out during 1935 were the erection of the screen house and the construction of a considerable length of concrete main carriers. Work on the sludge and supernatant water pumping station is in progress, and it is anticipated that the disposal works will be put into operation during the coming summer. The expenditure on works completed and in hand amounts to approximately £750,000. The principal works remaining to complete the scheme are the completion of the new Leen Valley sewer between Basford and Bulwell, and the sewerage of the Dunkirk district of the city.

Plymouth.—Reconstruction of the Camel's Head sewage purification works has been decided upon by the Plymouth City Council, and design by Messrs. J. D. and D. M. Watson, of Westminster, is now proceeding. The existing works were constructed in 1906 and receive the flow from a population of about 17,000, including about 2800 residents in the Plympton rural district. It is proposed to extend the drainage area, and the new purification works

will be designed to treat fully the flow from a population of 30,000. The "activated sludge" method of treatment will be adopted and sludge will be digested before being pumped to an isolated site for disposal. The site of the works is on estuarine mud, being a reclaimed portion of Camel's Head Creek, and it is anticipated that the foundation works may be difficult. A trial bore-hole contract has already been completed.

Sheffield.—A new sewage pumping station is at present under construction at an approximate cost of £3000. It became necessary owing to the site of the old station being required for road widening. In October work was begun on a new sewage disposal works at Coisley Hill, the cost being estimated at £40,000. The bio-aeration or activated sludge process is being adopted. The construction of these works has become necessary owing to development of several estates in that part of the city. The work is being carried out by administration.

Swansea.—The new main trunk sewer, which is about 11½ miles long, extending from the northern borough boundary at Clydach down the Swansea Valley and through the centre of the town to a controlled outlet with screening chambers and storage tanks near Mumbles Head, discharges into the tidal waters of the Bristol Channel. The work has now practically been completed and the sewer is to be put into operation early in the present year. The cost of this part of the scheme is £1,111,000. Three contracts for subsidiary sewers, pumping stations, &c., entailing a total cost of £128,000, are now in progress, and a further contract for similar work will be let early in the present year.

As far as water supply is concerned there is at the moment under construction a ferro-concrete service reservoir of approximately 750,000 gallons capacity which, it is hoped, will be finished during the coming summer. Approximately 4 miles of 12in. bitumen-lined steel main are being laid in connection with this work. The estimated cost of the works is in the neighbourhood of £25,000.

Tamworth.—The sewage pumping plant in Lichfield-road being inadequate, Messrs. J. D. and D. M. Watson, of Westminster, the consulting engineers, prepared a scheme comprising the construction of four storm-water tanks adjacent to the pumping station and the replacement of the existing pumps by five electrically driven, automatically controlled, vertical-spindle centrifugal pumps. Cameron and Pooley, Ltd., of Erdington, Birmingham, whose contract amounted to approximately £3392, carried out the construction of the tanks, &c., and the structural alterations at the pump house. The contractors for the new pumping installation are Tangyes, Ltd., of Birmingham, with the English Electric Company, Ltd., as principal sub-contractor, and the value of the contract is roughly £2000.

Wolverhampton.—Plans are in preparation for the provision of four gravity-fed bacteria beds, total capacity 10,000 cubic yards, with the necessary humus tanks and other ancillary works. This will bring the total bacteria bed capacity to 73,000 cubic yards.

France.

Water Supply.—The expectation that work would be started before the end of the year upon the Vals de Loire scheme for bringing a million cubic metres of water to Paris daily was not fulfilled, the reason being that the company could not pay the rate of interest required in these times of dear money for the considerable loan it was authorised by the State to issue. Until that can be done, work in the Vals de Loire is limited to preparations for transporting material and for trenching and laying the porous concrete collectors along the deep water laden sandy bed. During the five to ten years that must elapse before Paris can receive water from the Vals de Loire, the existing supplies are being augmented by rapid filtration at the Saint-Maur beds, while an ozone installation capable of sterilising about a third of the filtered supply is superseding the experimental plant that has been in operation for many years. This dependence on the Seine and Marne for adequate supplies is rendered possible, it is believed, by the flood reservoirs which are expected to prevent the water level from falling unduly in times of drought. A second reservoir was completed last year, and work is being started upon a third. At Marseilles the problem of dealing with water brought from the river Durance by a canal, and at times so turgid as to offer great difficulties in filtration, was entirely solved during the year by the completion of a new installation comprising pumps at Sainte-Marthe, decantation basins with baffles in which colloidal matter is coagulated by alumina sulphate produced at the station itself, and filtering beds having a capacity of 3,800,000 gallons a day. An ozone sterilising plant is also installed. On account of the financial stringency, little progress could be made with other municipal schemes, of which there are several, including one for the town of Charleville, in the Ardennes, where water is to be brought from a river source 15 miles away. Of equal importance is the rural supply which is aided by subventions from the State, and the State has also a technical organisation for the benefit of rural authorities desirous of making the best of the water available. This work was carried on actively until two years ago, when the amount of subvention was temporarily reduced, and though money has since then been allotted to rural water supply out of the public works relief fund, there was a slowing down of such work during the past year. Borings for subterranean water had to be controlled in consequence of a reported continuous fall in level in the Paris area, and the Government published a decree that no artesian wells could be sunk to a depth of more than 80 m. without State sanction. The State intends to prospect and classify subterranean water throughout the country.

Sanitary Engineering.—The completion of the sewage main from Pantin, north of Paris, to where it joins the main from Saint-Denis to the sewage farm at Achères, was the first step in carrying out the programme of sewage disposal in the Department of the Seine. For the rest, the plan proceeded as rapidly as possible with the financial resources available, and for the sake of providing employment was limited to the laying of mains, while preparations were made for the reconstruction of the Clichy decantation works which are to deal with a considerably larger volume of sewage in the future. The laying of mains around Paris, and from Paris to the Achères farm, will occupy some years, so that the activated sludge installation at Achères will be put in hand at a later date. Elsewhere, sewerage developments offered little interest. For the disposal of refuse, the Health Committee has failed in its efforts to find methods of destruction suitable for small towns and communes, and it is now suggested that systems of incineration at high temperatures may be adapted satisfactorily to plants required in centres with small populations. Research is being continued in this direction. The collection of refuse made striking progress in Paris during the year in the way of economy, hygiene, and cleanliness, by the introduction of closed vans with automatic packing of the refuse when dumped in behind through dust retaining screens. Several systems on this principle are being tried, and the first one introduced has already been adapted to more than a hundred old omnibus chassis.

Shing Mun Valley Waterworks, Hong Kong.

Work on the dam, which will be 275ft. in height above stream bed, proceeded actively throughout the year. Some 89,000 cubic yards of concrete have now been placed in the retaining wall or "thrust block" supporting the reinforced concrete diaphragm face, representing about two-thirds of the total volume, and about 271,000 cubic yards of rock, or rather more than half the total quantity, have been deposited in the rock fill downstream of the thrust block. The diaphragm face has been completed to a height of about 170ft. above the river bed, and about 15,500 cubic yards of concrete have been placed in the tongue trench, which has now reached the same level. The concrete lining of the diversion tunnel was completed during the year and the concrete lining of the overflow tunnel was finished as far as the bottom of the bellmouth overflow. One hundred and forty feet out of a total height of 270ft. of the valve shaft have been completed. Work continued on the Pineapple Pass subsidiary embankment, about 127,000 cubic yards of material having been placed in the earth embankment, stone toe, and rock fill, representing rather more than half the total height. In view of the water situation, the work of construction has been so carried out as to enable water to be impounded temporarily, in order to provide an additional supply during the dry season, and partial filling commenced on September 2nd, the reservoir being in a position to hold 500 million gallons. The work is being carried out for the Government of Hong Kong by direct administration to the designs and under the supervision of Messrs. Binnie, Deacon and Gourley, the resident engineer being Mr. G. B. Gifford Hull, M. Inst. C.E.

Rangoon.

The same firm of consulting engineers has given us the following details of the Rangoon water supply. The necessity for augmenting the water resources has exercised the minds of the Corporation for a number of years past, and it has now been decided to carry out the Pegu Yomas scheme. This project comprises a storage reservoir formed by an earthen embankment 136ft. high, a pipe line 44 miles long, and a booster station. Surveys are at present in hand, and it is hoped to begin construction this year.

The Physical Society's Exhibition.

No. I.

LEADING scientific instrument makers and kindred firms engaged in the construction of scientific apparatus were showing their latest products in the trade section of the Physical Society's twenty-sixth annual exhibition, held from January 7th to 9th at the Imperial College of Science and Technology, South Kensington. Nearly all firms in the habit of exhibiting and a few more were present, thus making the show as attractive and instructive as ever, especially from the point of view of electrical people, who for a long time past have been exceptionally well catered for. Electrical instrument design has kept well abreast of other electrical advances, and this annual exhibition is the means of bringing to light the most recent developments in this and other directions. It is an exhibition that can only be fully appreciated by close and careful study, for the things to be seen are numerous, and in some cases intricate. Those interested in all things scientific can scarcely hope to derive full benefit from the show during its short period of existence, but the needs of the average visitor seeking specific knowledge are no doubt met.

The research and experimental section (always well patronised) contained, as usual, exhibits of research laboratories, such as those of the N.P.L., the E.R.A., and the G.P.O. There was a special sub-section devoted to experiments of educational interest.

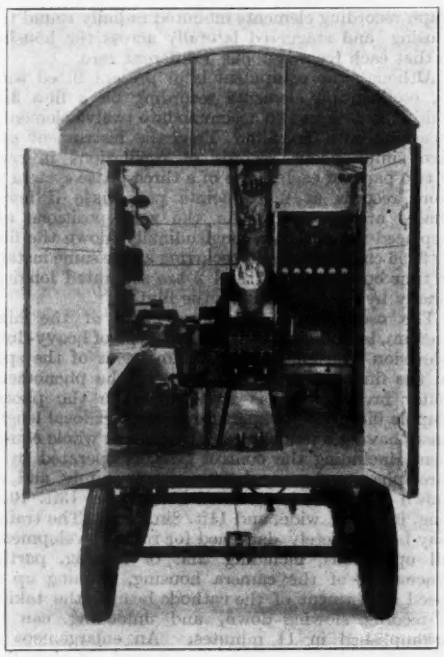


FIG. 1—OSCILLOGRAPH MOUNTED ON TRAILER

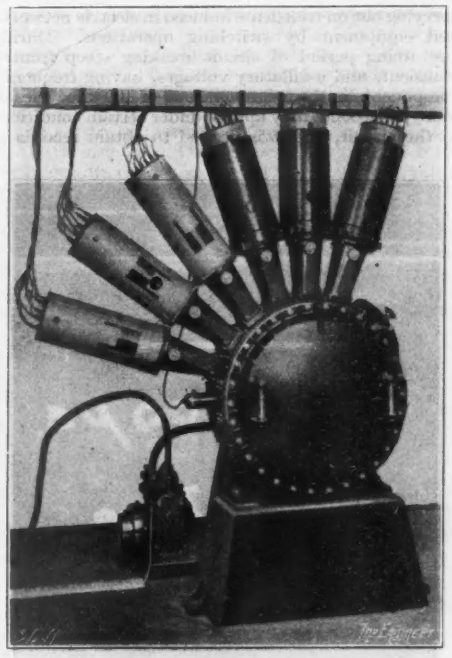


FIG. 2—SIDE VIEW OF OSCILLOGRAPH

Work submitted by apprentices and learners for the craftsmanship and draughtsmanship competition was again another attractive feature of the show, which may be said to have been in all ways up to the usual standard. The discourses were delivered on this occasion by Messrs. R. A. Bull and R. W. Paul, who dealt respectively with "Some Instruments used in Recording Sound on Film" and "Electrical Measurements before 1886."

Never, to the best of our belief, have exhibits of

the British Electrical and Allied Industrial Research Association been more attractive than they were on this occasion. The portable multiple-element cathode ray oscillograph—Figs. 1 and 2—for giving on a rotating film six to twelve simultaneous records, was perhaps the outstanding exhibit of this organisation. Designed jointly by the Research Association and the Cambridge Instrument Company, it is intended mainly for use in the field investigations the Association is carrying out on transients induced in electric networks and equipment by switching operations. During the arcing period of circuit breaking steep fronted transients and oscillatory voltages, having frequency components in the neighbourhood of 100 kilocycles or more per second, may appear under certain conditions in the circuit, and it is desired to obtain records of these under practical operating conditions. In order that frequencies of this nature may be clearly delineated, successive waves should have approximately 1 mm. linear separation, entailing a speed of traverse of the recording medium of 100 m. per second, and since it is necessary to record over a period of several cycles at supply frequency, a drum camera with a high peripheral speed is required. The drum used is 2 m. in circumference, and has a peripheral speed of about 95 m. per second, the film being exposed during one or more drum revolutions. Since the drum speed is about 2850 r.p.m., a 50-cycle supply wave will occupy 190 cm., or 10 cm. less than the total drum periphery. Successive cycles will thus be displaced by 10 cm. on each revolution of the drum, which runs in a partially evacuated housing to minimise air friction losses. The outfit consists in the main of a cast bronze housing carrying a rotor with the oscillograph recording elements mounted radially round the housing and staggered laterally across the housing so that each records about a different zero.

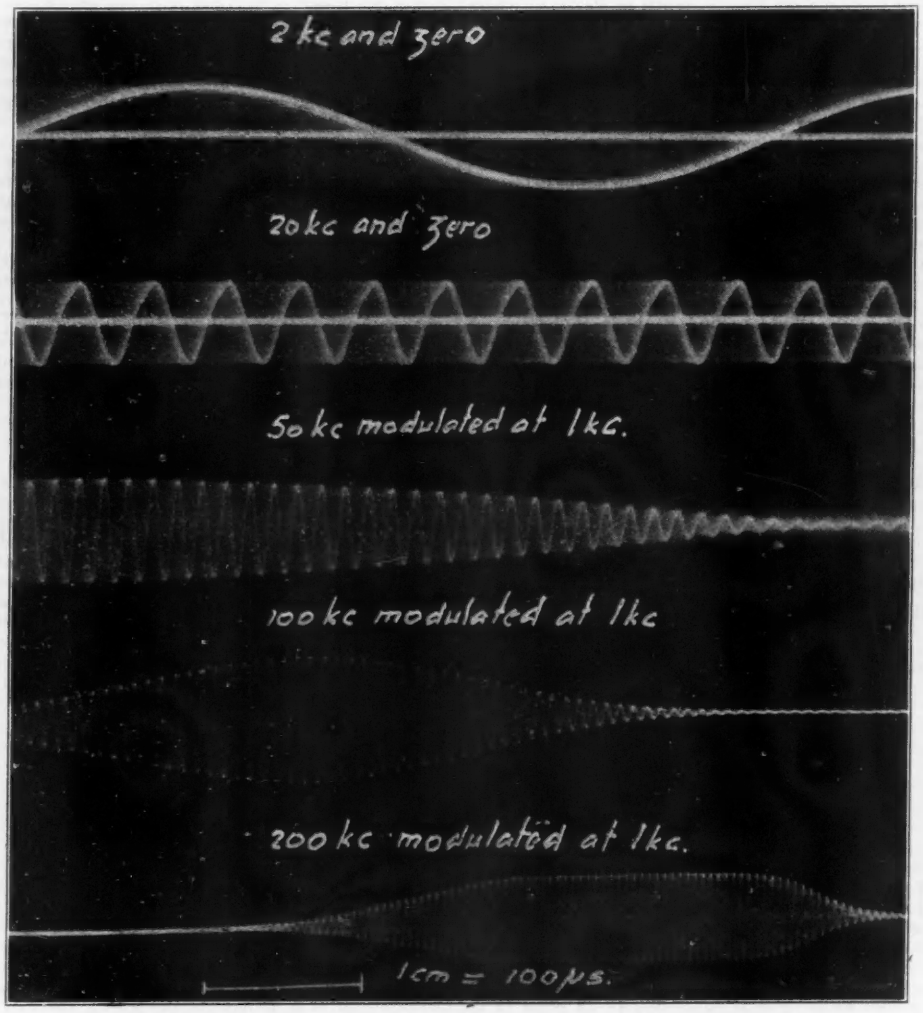


FIG. 3—ENLARGEMENT OF CATHODE RAY RECORD SHOWING FIVE TRACES

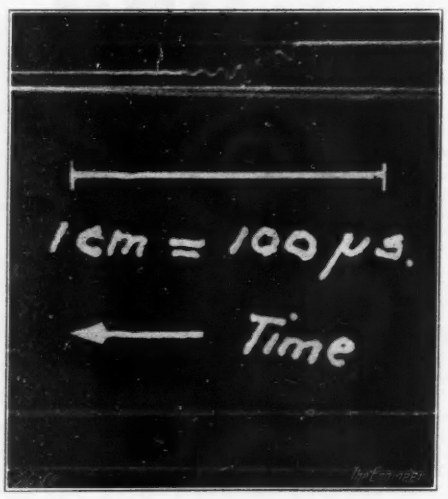


FIG. 4—CATHODE RAY RECORD SHOWING TRANSIENT

Although the equipment is at present fitted with six oscillograph elements recording on a film 3in. wide, it is designed to accommodate twelve elements, recording on a 5in. film. Thus the instrument can give simultaneous records of oscillations in each of two parts of each phase of a three-phase system or more records at more points per phase if fewer phases are involved. As the zero positions are displaced radially (*i.e.*, longitudinally) down the film by 9·96 cm. phenomena occurring at the same instant of time on elements, 1 and 2 are separated longitudinally by that amount on the film.

The oscillograph elements consist of the high vacuum, high definition sealed off type of heavy-duty television transmitter tube. Movement of the spot on the fluorescent screen caused by the phenomena under investigation is transmitted to the photographic film by wide aperture ratio short focal length lenses having a reduction of 10 : 1. The whole equipment, including the control gear, is operated by a three-phase and neutral 400–400-volt supply, and, as shown in Fig. 1, is mounted in a trailer 13ft. 10in. long, 6ft. 10in. wide, and 11ft. 8in. high. The trailer may be completely darkened for rapid development. All operations, including that of loading, partial evacuation of the camera housing, running up to speed adjustment of the cathode beams, the taking of records, slowing down, and unloading, can be accomplished in 11 minutes. An enlargement of a portion of the cathode ray record showing five traces of simultaneous phenomena, illustrating the ability of the instrument to record oscillations up to frequencies of 200,000 cycles, is given in Fig. 3. where the blurring behind the trailing edge at the lower frequencies is due to the after-glow of the flourescent screen. An enlargement of a portion of a cathode ray oscillograph, showing a transient with an oscillatory frequency of 160,000 cycles, is given in Fig. 4.

A receiver—Fig. 5—exhibited by the Association, is for the investigation of short-wave interference radiated by ignition systems. At wavelengths below 10 m., this interference becomes particularly important and its effect on a proposed telephone service may be serious. The super-heterodyne receiver consists of a frequency change stage, an intermediate frequency amplifier, and a peak voltmeter, shown diagrammatically in Figs. 6, 7, and 8 respectively. There is also an anode bend detector, shown in the lower part of Fig. 8, and it is used for monitoring purposes. The receiver is designed to work from 6 m. upwards, and a tuned frame aerial connected directly to the grid of the frequency-changing valve is employed for most measurements, but a half-wave length dipole aerial can be used when greater sensitivity is desired. A series of plug-in frames covers the necessary frequency range. A triode-heptode frequency changing valve, designed for short-wave operation, is used for the frequency-changing stage, the oscillator frequency range being covered by plug-in coils. From the frequency changer the output is passed through an I.F. amplifier tuned to 1 megacycle. This amplifier has two stages of amplification, and uses a modification of the buffer amplifier method. An overall gain of 200,000 is obtained from the amplifier, which gives linear results up to 20 volts or so. To make the instrument suitable for measuring a wide range of field strengths, the amplifier is provided with alternators, which vary the sensitivity by 100 decibels in steps of 10 decibels, as indicated in Fig. 7. The output from the I.F. amplifier is measured on the peak screened grid valve voltmeter, which is without an external leak, a backing-off device being employed so that the output meter reads zero when there is no potential on the grid. The voltmeter has a range of about 2 volts peak and the relation between

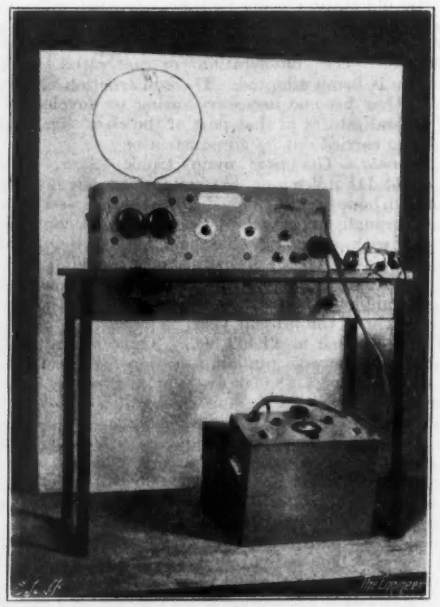


FIG. 5—STANDARD RECEIVER

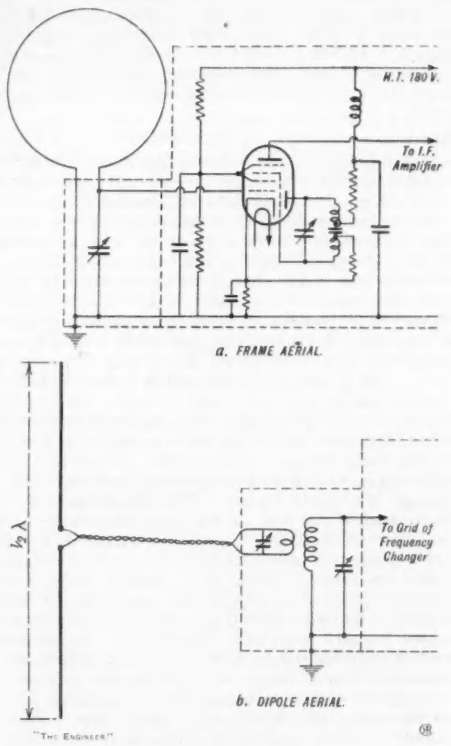


FIG. 6—INPUT FREQUENCY CHANGER CIRCUITS

input voltage and meter reading is substantially linear. For mounting purposes the anode bend valve voltmeter shown in the lower part of Fig. 8 is used.

Calibration is effected by producing a known field strength at the aerial by means of a small screened oscillator, coupled to a small loop fitted with a thermo-

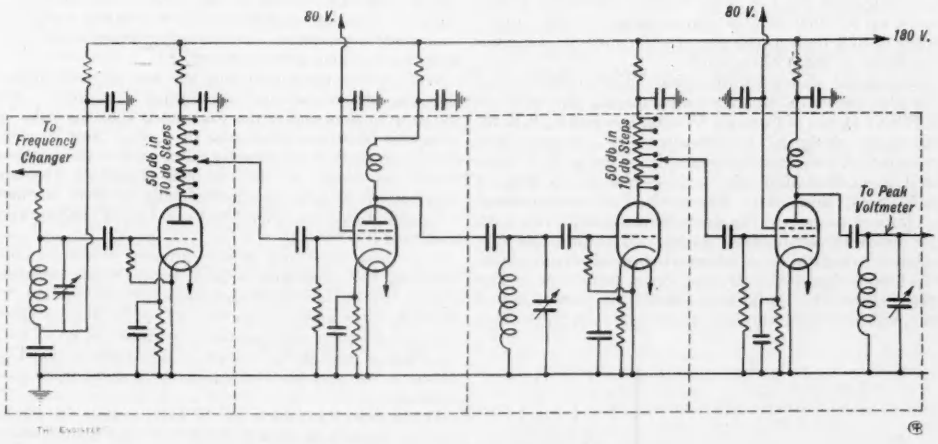
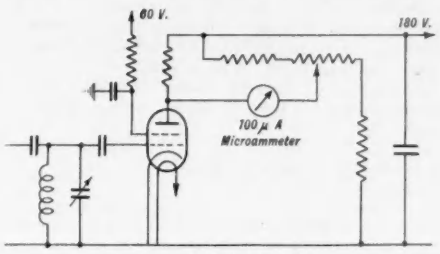
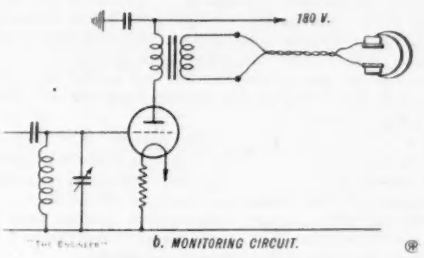


FIG. 7—INTERMEDIATE FREQUENCY AMPLIFIER

milliammeter at the point of low potential. The field at the aerial can be calculated from the dimensions of the loop, the current in the loop, and the distance of the loop from the aerial. Linearity of the frequency change was established by injecting voltages with a signal generator and the receiver may be regarded as a tuned high-frequency peak valve volt-



a. PEAK VOLTMETER.



b. MONITORING CIRCUIT.

FIG. 8—OUTPUT METER CIRCUITS

meter. Under normal working conditions the field strength of radiation emitted from motor vehicles has been measured, and it has been found that the peak valve voltmeter records satisfactorily the "annoyance" effect of each radiation. Simultaneous measurements with the E.R.A. receiver and the field strength measuring apparatus of the B.B.C. on the 7·75 m. transmitter of Broadcasting House, has shown very satisfactory agreement.

Space limitations will not allow us to deal with all the other E.R.A. exhibits, which related, among other things, to the use of Schlieren apparatus to show isothermals around hot bodies, a method of obtaining and controlling high humidities at high temperatures, and a burner for use in naked flame tests on dielectrics. The burner is employed as the source of heat in naked flame (inflammability) tests on solid electrical insulating materials, the coal gas flame being unsuitable, as it is subject to temperature variations which may exceed 500 deg. Cent., according to the composition of the supply used. Employing a standardised fuel (*i.e.*, industrial alcohol to B.S.S. 3 D 9) the burner is immune from such variations, and is, furthermore, the source of a flame which is reproducible to within plus or minus 10 deg. Cent. A ready and convenient means of arbitrarily adjusting the temperature of the flame has been developed for use as a practical check upon operation. A No. 22 S.W.G. copper wire inserted in a given position in the flame melts in 5½ to 6 seconds. If the wire takes longer to melt, adjustments are made until the desired result is achieved. A change in melting time of from 5½ to 7½ seconds represents, at the normal flame temperature, a change of approximately 20 deg. Cent., and it is therefore a simple matter to adjust the temperature of the flame to within the limits mentioned.

A magnetic crack detection apparatus for testing raw materials or finished parts for freedom from cracks was among the exhibits of the Metropolitan-Vickers Electrical Company. The method involved depends upon the fact that the magnetic susceptibility of a fault is inferior to that of the surrounding magnetic material. A crack, blow-hole, or slag inclusion acts as an air gap or discontinuity in the path of magnetic flux caused to flow in the material in such a direction that it crosses the defect substantially at right angles. The flux and its direction are produced and controlled by current windings or permanent magnets. A defect or discontinuity lying across the magnetic flux path causes the flux to bend round the fault, and to seek an alternative path in the sound material surrounding it. If the fault is a small crack at the surface of the material, the field distortion is very local, whilst a larger or internal fault entirely surrounded by sound material gives a field distortion over a larger region. By making the intensity of magnetisation high enough, it is possible in any case to make the distortion extend beyond the surfaces of the article into the air surrounding it, and it is this external field effect which makes magnetic crack detection possible. Defects are located by scanning the surfaces of articles with devices sensitive to local external field distortions. Various forms of search coils, may be used.

A method, which is both effective and simple, is shown in Fig. 9, where the distorted field arising from the internal fault C on the highly magnetised article A actuates a short magnetic needle B, pivoted at its centre. The needle moves a pointer D over a scale E, with a right and left motion, as the needle follows the field distortion passing beneath it. With the aid of a mirror and a reflected light beam on a distant scale, the sensitivity of the device can be increased. The article tested is magnetised by current windings, which embrace the article and detector, and whilst the coils are stationary the article is passed through them, so that the only variable is the material under inspection. The method is particularly applicable to transverse faults in long uniform-sectioned articles, such as steel rails and rolled stock. Turbine wheels and locomotive tires can be inspected by magnetising with current turns wound radially.

A common type of fault likely to grow in seriousness with time and stress is the surface crack too small to see with the unaided eye. Such cracks may be caused by sudden temperature changes when grinding or quenching an article. These minute defects produce very local surface distortions of magnetic flux which can be made to reveal themselves by sensitive methods of detection. If a piece of paper be laid on such a magnetised surface and fine iron filings be scattered over it, these will migrate to the spots where the defects occur if assisted by lightly tapping the paper. With finer particles and sifting or blowing directly on to the surface, more sensitivity is obtained. If oil is mixed with the magnetic particles, the mixture can be swilled or flowed on, or the article can be immersed in the mixture. A permanent record of the defects is left on the material and the method is extraordinarily sensitive. In most cases the residual flux left after magnetisation is sufficient to locate the defects. While the fine magnetic fluid method of crack detection is very effective, it is also very dirty, and a clean and simple portable detecting device has therefore been developed. It consists of a shallow, circular brass dish with a thin flat back and a transparent cover, filled with a mixture of magnetic dust and oil. It is held in the hand and shaken with a rotary motion to mix the magnetic dust and oil thoroughly. Whilst in this state it is placed horizontally on the surface of the magnetised article to be inspected. As the magnetic particles settle to the bottom of the bath, they migrate to the spots where the defects occur. The brightly plated bottom of the bath shows up these collections of dark particles by contrast, so indicating the slightest discontinuity. The device is very effective, and there appears to be little or no loss in sensitivity owing to the interposition of the thin back between the detecting fluid and the surface being examined.

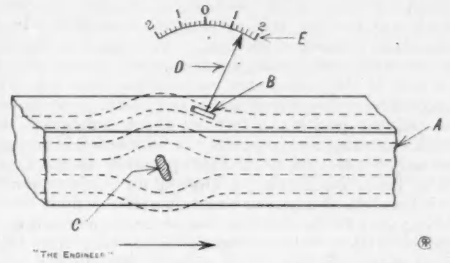


FIG. 9—METHOD OF DETECTING CRACKS IN METAL

Another Metrovick exhibit was the load-limiting relay, shown diagrammatically in Fig. 10. It is designed to reduce the load peaks on domestic and other installations by temporarily disconnecting one part of the load for as long as another part exceeds a prearranged value. When properly applied it reduces the maximum demand and improves the load factor of the installation without loss of revenue to the supply authority, and without inconvenience to the household. Though primarily intended for use in private residences it may be employed in other places in which it is desired to reduce the peak load. The current limiter consists of two parts (1) a current-measuring device and a shunt connected in, say, the cooker circuit, and (2) a special switch controlled by the measuring device and connected to interrupt, say, a water-heater circuit. Both parts are mounted together in a case of the house service meter pattern.

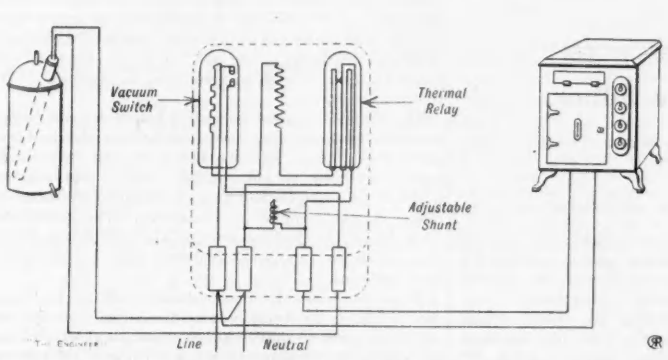


FIG. 10—LOAD LIMITING RELAY

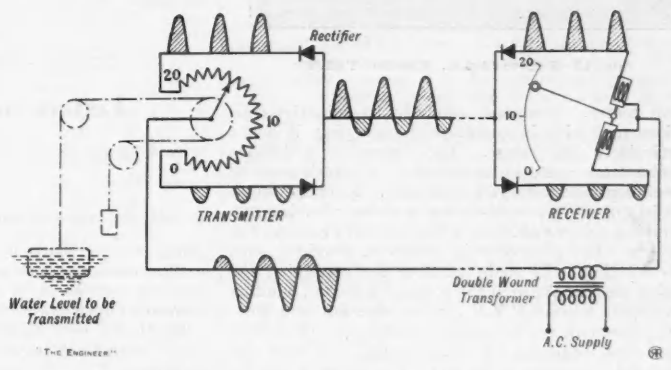


FIG. 11—EVERSHED-MIDWORTH TELEMETER

The current-measuring device is a simple thermal relay with a bi-metal strip with a contact at its free end enclosed in an evacuated glass tube to ensure freedom from contact troubles and to reduce the amount of energy required for operation by conserving heat. A shunt carrying the cooker current serves to operate the relay, and is used for calibrating the measuring device.

At full load the drop across the shunt is only 75 millivolts. The measuring device can be set to operate at any current from 5 to 10 ampères, and will carry a load of 30 ampères continuously, the difference between the "pick up" and "drop off" values being less than 5 per cent.

The switching device is a standard "Sun-Vic" vacuum switch, and, like the parts of the current-measuring device, those of this switch are in an evacuated glass tube. The contacts are opened and closed by the expansion and contraction of a wire filament, which takes about 6 watts, under the control of the measuring device. A voltage drop of about 0·3 volt occurs across the switch, which is designed to break 10 ampères at 230 volts without arcing or burning occurring at the contacts. The load-limiter switches off the water heater only when the cooker load is heavy and keeps it switched on under the control of the thermostat at all other times.

One of the most interesting exhibits of Evershed and Vignoles, Ltd., of Acton-lane Works, Chiswick, W.4, was the Evershed-Midworth telemeter system, shown diagrammatically in Fig. 11. It is a recently developed A.C. system for indicating at a distance the level of water in reservoirs, or for indicating other quantities. The principle involved is that of controlling A.C. so that the two components of the wave, which are normally symmetrical above and below the zero line, are made asymmetrical to any desired extent for the purpose of transmitting indications. A.C. is supplied to the circuit through a transformer as shown.

The transmitter consists of a wire-wound resistor connected at each end to copper oxide rectifiers, and is traversed by a silver contact roller operated by a float or other mechanism. On entering the transmitter the A.C. is split into its two components by the rectifiers oppositely connected, and the magnitude of these components is regulated by the point of contact of the roller on the resistor. On leaving the transmitter the components are again combined and the current is therefore more or less asymmetrical, depending on the position of the contact roller. This asymmetrical current is passed over a pair of pilot wires to the receivers, which are moving coil ratiometers containing two oppositely connected rectifiers which again separate the current components, each component energising one coil of the ratiometer movement. The relative magnitude of the components, therefore, determines the pointer position. Two or three indicating or graph recording receivers may be connected in series, and only 6 watts are needed for operating them. Post Office lines, consisting of two pilots (or one pair) may be used, changes in resistance of the pilot lines having very little effect on the accuracy of readings. The insulation value between pilots may also fall to an extremely low value without introducing any observable error.

The firm's geophysical Megger earth tester, shown in Fig. 12, is a development of the ordinary Megger

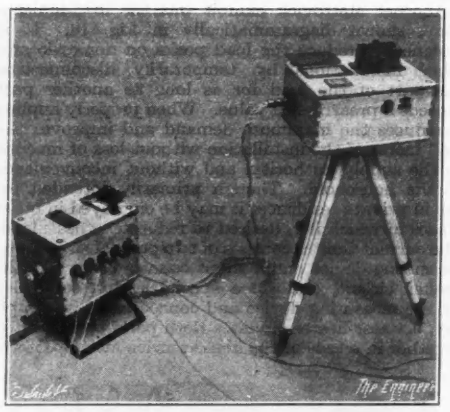


FIG. 12—GEOPHYSICAL EARTH TESTER

earth tester. Designed specially to suit the conditions met with in geophysical surveying, it has a particularly low range. The values of resistance obtained are quite independent of the resistance of the current and potential electrodes. The instrument consists of a D.C. hand-driven generator having two reversing commutators as in the ordinary commercial pattern. The generator is, however, provided with two windings, the main winding for supplying the testing current through the soil and a second winding developing a lower E.M.F., which, through an adjustable potentiometer, is made to produce a back E.M.F. equal and opposite to that existing between the potential electrodes in the soil. The point of balance is observed by a sensitive reflecting galvanometer. In the balanced position no current flows through the potential electrodes and the readings obtained are therefore unaffected by the resistance of these electrodes. The current passed through the soil is made alternating by the reversing commutator, so that the results obtained are unaffected by any electrolytic or back E.M.F. or stray currents in the soil. The resistance is measured by a direct-reading ohmmeter, the deflecting coil of which is actuated by the back E.M.F. of the potentiometer, the control coil being in series with the main current flowing through the soil. No calculations of any kind are necessary. After the potentiometer has been adjusted the instrument gives the resistance under test directly on the scale, as long as the handle of the generator is turned. The instrument has two ranges of 0–0·3 and 0–3·0 ohms. On the lower range of 0–0·3 ohm the instrument has been designed for use with current electrode resistances up to 2000 to 3000 ohms each. On the upper range of 0–3·0 ohms the permissible current electrode resistance is 6000 ohms each.

Indicating and recording ring balance meters for draught, pressure, and flow were among the exhibits of Elliott Bros., of Century Works, Lewisham, S.E.13. They are designed to measure the draught and pressures of low-pressure gases, air, or water, and when used in conjunction with orifice plates the flow of such gases, fluids, &c. The method of measurement is claimed to ensure the greatest accuracy even with the smallest variations. As Fig. 13 shows, the ring balance consists of a counterbalanced drum, half-filled with liquid and pivoted on a knife-edge. The space above the liquid is divided by a partition and the pressures to be measured are conveyed to the two

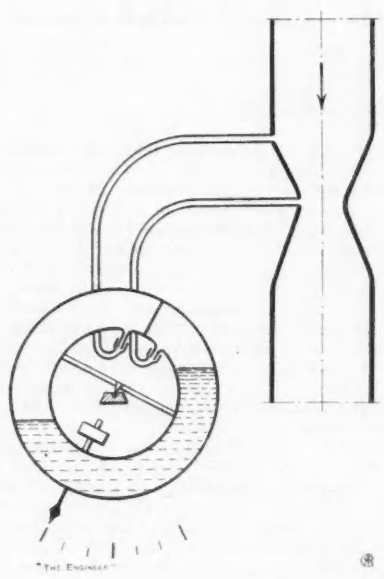


FIG. 13—RING BALANCE METER

spaces by means of flexible tube connections. When the two pressures differ, owing, say, to an alteration in draught or flow through an orifice plate, the liquid is displaced, but the drum rotates until the counterbalance in its new position balances the displaced liquid. The angle through which the drum has turned is a measure of the pressure difference which caused the displacement, the accuracy being unaffected by the quantity or specific gravity of the liquid used. By changing the counterbalance weight the instrument range may easily be altered. For low-pressure measurements these meters are claimed to be very accurate, whilst when used as flow meters there is very little loss of head. There are no moving parts in the pipe line. Indicating and recording instruments are available and distant transmission of the readings may be arranged for, if desired. In Fig. 13 a ring balance meter is shown connected to a venturi tube for the measurement of flow. Most of the remaining exhibits of this firm, such as the Elliott transmission system for remote indicating and recording and the Shotter maximum demand ammeter, have previously been described in our columns.

(To be continued.)

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

TRADE AND CURRENCY DEVALUATION.

SIR,—I should like to make a few remarks in an attempt to illuminate the dark and dreary picture which Dr. Schindler portrays in his report, which you, Sir, so ably commented upon in your issue of December 20th.

The Doctor very rightly says that the epoch of mad import restrictions began before the war, but has been much intensified since that upheaval, and is now a world-wide disease. Whilst condemning this madness, I think we ought to diagnose its causes and endeavour to find a cure.

Dr. Schindler points out that during the war prices rose, and consequently wages and salaries also rose proportionately. Since then prices have dropped again prodigiously, but there is a "disinclination to reduce wages and salaries." Surely we have here at once an inkling as to the cause of our disease! With prices of industrial products down, whilst costs remain up, the employers find it impossible to carry on. As they are powerless to reduce salaries and wages and other fixed charges, they naturally seek for some way to raise the prices of their produce as the only alternative to the closing down of their factories. The readiest way to raise prices is to restrict foreign competition, and so this blatantly uneconomic method is almost universally resorted to.

The alternative method of keeping the costs of production in true relationship to the value of the produce is that of currency regulation. The Doctor condemns "currency depreciation" in withering terms, but has he given the question any close study?

When prices went up during the war, it really mean that the value of each unit of currency went down. And the drop in prices since the war means that the value of each unit of currency has gone up again. Now it seems obvious to me that it is this rise in the value of the currency which has caused all the trouble. Therefore why not depreciate it to something approaching the level at which the scale of salaries, wages, and other fixed charges were stabilised?

It is these variations in the currency values (as indicated by the variations in price levels) which dislocate the whole economic world, and cause nations to adopt the methods of the madhouse in the way the Doctor describes. Surely the cure is to regulate the currency so as to keep the value of each unit constant, at a suitable level. This means, of course, the keeping of the general price level constant.

If this were done there would be no excuse for tariffs, quotas, restrictions on output, or any other abominations of this kind. But until this scientific remedy is applied, the quack poison of restrictive methods is not only unavoidable, but is practically necessary.

Acute economic pressure compelled Great Britain (much against the wishes of its leading financiers and statesmen) to de value its currency in 1931, and at once we felt the relief in the shape of improved trade and reduced unemployment. Switzerland and France are still blindly struggling against the pressure of economics and common sense, and are suffering accordingly—even more than we are.

Dr. Schindler appears to imagine that currency devaluation in any one country is adopted simply to get the better of its neighbours. I think this is quite erroneous. A rectification of currency values primarily improves internal industry. But, of course, foreign trade also benefits.

HENRY SYKES.

London, S.E.1, December 30th.

SMALL SCALE TESTS.

SIR,—There is a form of research in which I suggest a good deal more can be done in ascertaining the fundamental factors of design than is being done at the present time, and that is by using small scale models. The best example of this class of research is, of course, the aeroplane, whose phenomenal development is due to the widespread use of the small scale model in various wind tunnels at home and abroad. No other industry considering its implication as one of manufacture and employment can be said to have developed at anything like the rate that the aeroplane has.

It will be said, of course, to account for this, that for various reasons—for instance, national defence—a great deal more money has been expended than could normally be expected for anything else. No doubt this is so, but it should be taken as an encouragement rather than a deterrent, for the more this economical form of research is practised the more the development possible.

To carry out a more widespread practice of this form of research as part of a regular plan might mean the setting up of a joint central body for the purpose of co-ordination and to prevent overlapping. One might take, as a useful example of research for which this class of apparatus is suitable, that of the blast pipe and smoke-box problem of the locomotive. A vast amount of practical work has been done in the development of this fundamental part of the locomotive, with a good deal, no doubt, of detailed research, yet there is no agreed practice. Any new locomotive to-day may find improvement by modification of the nozzle or its position. A small scale apparatus should provide a great deal of information that would materially help practical design in the end. Of course, the scale effect might be there as with an aeroplane, but probably not to the same extent.

The various forms can be readily tested in a comparative manner, the simple type as ordinarily used, the double one as used in France, and the L.N.E.R., the variable one, hand controlled or with jumper valve, and maybe a multiple jet type, bearing some relation to the latest and most efficient form of jet condenser. The considerable variation of the back pressure in the cylinder in locomotives, with its consequent reactive effect on economy, is very material.

When one hears the quiet exhaust of the turbo locomotive, with its abnormally low discharge pressure, with still the ability to make enough steam, and which is said to explain the economy of the atmospheric exhaust type turbine, one wonders why something of this type has not been developed and applied to the ordinary reciprocating locomotive.

January 6th. H. O. C.

THE installation of a wireless beacon at Croydon Aerodrome has been begun, and it is expected to be in experimental use within a month.

Rail and Road.

To improve the means of communication between the main line and the Central London stations at Liverpool-street the L.N.E.R., in co-operation with London Transport, is to construct a new subway between the Central London booking hall and the concourse facing the suburban platforms on the west side of the main line station. The new subway will shorten the distance between the Tube and the main line stations and relieve congestion in the rush hours. The work is to start as soon as possible.

THE Ministry of Transport railway statistics for September last show that, when compared with the corresponding period of 1934, the number of passenger journeys increased by 2·7 per cent., but the receipts from passengers decreased by 1·4 per cent. There was a decrease of 2·2 per cent. in the tonnage of freight carried, and of 1·0 per cent. in the freight train receipts. The freight train mileage was reduced by 0·3 per cent. The average train load decreased from 125¼ to 124¼ tons, and the net ton-miles per engine-hour from 464½ to 463.

FIGURES issued by the Ministry of Transport on January 2nd show that there was a gratifying reduction in the number of fatal and non-fatal road accidents last year as compared with 1934, owing, it is suggested, in part to the safety measures introduced by the Minister of Transport, such as pedestrian crossings and the 30 m.p.h. speed limit in built-up areas. The figures are :—Killed, 6521 in 1935, as compared with 7543 ; a daily average of 18, as compared with 20 ; injured, 218,798 in 1935, as compared with 231,603 in 1934, a daily average of 599 in 1935, as against 634 in 1934.

THERE was only one accident on British railways during 1935 in which passengers lost their lives. That was the collision of June 15th at Welwyn Garden City, L.N.E.R., by which thirteen passengers were killed. Thus, as regards the number of accidents, there was the same comparative immunity as in the years 1932, 1930, 1929, and 1925. The total of 13 fatalities has, however, rarely been exceeded ; in fact, only in four individual years since the disastrous year of 1915, *i.e.*, 17 in 1934, 48 in 1928, 27 in 1927, and 24 in 1924. As the thirteen fatalities in 1935 were in one accident, the following records of individual accidents may be useful :—15 killed at Charfield, October 13th, 1928 ; 24 at Darlington, June 27th, 1928 ; 14 at Lytham, November 3rd, 1924 ; 18 at Jarrow on December 17th, 1915 ; 224 at Quintinshill on May 22nd, 1915.

THE first railway communication on the eastern side of the city of Manchester was given by the Manchester and Leeds Railway, whose terminus was in Oldham-road. Thence an extension was subsequently made by a line to Hunt's Bank, which left the main line at Miles Platting and descended into what later became the bay lines of Victoria Station. The descent was on a gradient of 1 in 40, which, as far as we can remember, has always been worked with safety. On the morning of Wednesday, January 1st, a mineral train, descending the bank, got out of control and, overrunning the signals at the entrance to the station, collided with the coaches that were to form the 9.54 a.m. train to Preston. Fortunately, the engine was not attached to the latter train, and the runaway simply pushed the passenger vehicles before it until it came to rest at the farther end of the station. The guard of the passenger train was seriously hurt.

SEVERE criticism was passed in *The Times* upon the working of the long-distance traffic on the Great Western on Christmas Eve. We have not had an opportunity of discussing the matter with any of the railway officers concerned, but feel justified in pointing out that the incidence of Christmas Day falling on a Wednesday was a prime factor in the unusually large traffic on Christmas Eve, as for the larger proportion of intending travellers the days for travelling are limited to Monday and Tuesday ; when Christmas Day is on a Thursday, there is, for many people a choice of three days. There must also be remembered the chaos created by the particularly dense and widespread fog on the Monday. Such fogs not only delay the running of trains, but the late arrival of the latter at their destination disorganises the return of the trains, as the vehicles intended for the formation of trains for the opposite direction are not available at the appointed time, and trains must wait until they are available, which often is done by "borrowing" the coaches that are in reserve for another train. It is so, but to a lesser degree, with locomotive power.

THE derailment of the Stranraer boat train between Parton and New Galloway, on the morning of December 30th, occurred in an area where there was another serious derailment, on October 14th, 1913. The train concerned on that occasion was a fish train running in the opposite—the up—direction, and the whole of its seven vehicles left the rails. The accident was inquired into by Sir John Pringle, whose report showed that the derailment occurred at the outgoing end of the passing loop at New Galloway Station—the line is single-tracked. The maximum theoretical safe speed at the turn-out was 19 to 20 m.p.h., and that was recognised by the imposition of a speed restriction through the crossing loop of 15 m.p.h. The evidence indicated that this was not observed by drivers. It was admitted that this particular train entered the loop at 20 m.p.h. and was travelling at 25 m.p.h. when it was derailed. The officers of the railway company did not appear to have been aware that the speed restriction at New Galloway had been habitually exceeded by express trains or to have taken any action to enforce the restriction. The fact that all express trains, both passenger and goods, pass through the station late at night may account to some extent for the fact that no notice had been taken of the infringement of the restriction. The superelevation of the up loop, over which the train was running, was also irregular. In places where the radius of curvature is from 25 to 50 chains, the level of the outer rail varied from 2½in. to as much as 4½in. above the inner rail, whereas, for the prescribed limit of 25 m.p.h., 1in. superelevation was sufficient. The timing of this fish train called for speeds varying from 35 to 49½ m.p.h., and maximum speeds of 55 to 60 m.p.h. cannot have been uncommon.

Miscellanea.

AN electric lamp factory with an approximate output of 3000 lamps a week has been opened at Corke Abbey, Bray, in Ireland.

ACCORDING to the monthly bulletin of the League of Nations the world's greatest oil production for one month was recorded in October when the petroleum produced amounted to 19,362,000 metric tons.

THE managing director of the United Steel Companies, Ltd., announces that the company intends to sink two pits at Warrington in the near future to obtain coal from an under-sea coalfield estimated to contain some 125 million tons of coal.

EXPERIMENTS in Soviet Russia during the past two years have shown satisfactory results in the production of gas from coal underground. Next year it is planned to open several new underground stations in the Donetz Basin for the gasification of coal.

EXPERIENCE in the working of Emmet mercury vapour boilers in the United States has shown that the introduction of a small percentage of metallic sodium into the mercury used successfully prevented blockages in the tubes due to the accumulation of deposits at the point of vaporisation.

DURING 1935, 350,000 new telephones were connected to the Post Office telephone system, the net increase, after deducting cancellations, being over 180,000, compared with 139,000 in 1934. The number of calls in 1935 was the highest on record. The number of effective local calls during the year is estimated at 1,755,000,000, or 158,000,000 more than in the previous year, and the number of trunk calls was 95,000,000, compared with 82,000,000.

A NOTE in the *Electrical Review* says that a 450 b.h.p. oil-electric railcar which was placed in service on the Buenos Aires Western Railway in October, 1934, has covered 125,000 miles without repair, and a smaller vehicle of 140 b.h.p. has run 51,000 miles in less than ten months. On the Buenos Aires Great Southern Railway the five oil-electric units which work the suburban traffic out of the Argentine capital have covered an aggregate of 550,000 miles.

A NOTE in the *Chemical Trade Journal* says that a rubber-lined fibre drum displayed at the recent Chemical Exposition in New York attracted considerable interest as a possible answer to the problem of packing and storing certain chemicals. It is claimed that these rubber-lined drums have successfully withstood tests made with 10 per cent. caustic soda solutions, 95 per cent. denatured alcohol, 10 per cent. sulphuric acid, and also boiling water. They may be steamed out without injury to the rubber lining or affecting its adhesion to the outside fibre shell.

SEVERAL world records for oil-engined motor cars have been made by Captain G. E. T. Eyston, assisted by Mr. A. Denly, on the Montlhèry race track in France. The records in detail were 50 kilomS. at an average of 98·681 m.p.h., 50 miles at 101·248 m.p.h., 100 kilomS. at 101·825 m.p.h., 100 miles at 102·925 m.p.h., 103·014 miles in one hour, and an average of 103·13 miles in two hours. The car was still running to attempt to break the twenty-four-hour record when one of the front wheels came off when travelling at a speed of over 100 m.p.h. Fortunately, Mr. A. Denly, who was driving, brought the car to a stop without mishap.

THE large combined railway and highway bridge over the Mississippi River near New Orleans was opened to traffic on December 16th last, and ceremoniously named "Huey P. Long." Over 4 miles of bridge structure have been constructed. The main bridge is 3525ft. long, and includes a 790ft. main cantilever span, two 530ft. anchor spans, a 530ft. through-truss span, and four deck truss spans. The railway approaches to either end of the bridge are of plate girder construction, and each is 8000ft. long. The highway approaches are of similar construction, but 3378ft. and 3003ft. long respectively. The bridge cost some 13 million dollars to construct.

SOME interesting figures in connection with the Holland vehicular tunnel, under the Hudson River between Jersey City and New York City, were recently given in a paper by Mr. A. C. Davis. He said that since the inauguration of the Holland tunnel on November 13th, 1927, 86 million cars had passed through the two tubes of the tunnel, the cost of operating which was 4000 dollars a day. The maximum number of cars that could be handled was 23,000 an hour per tube, and the actual daily was 57,700 cars. On the opening day 52,000 cars passed through, the largest number of cars handled in any one year being the 12,700,000 of 1930–31. The figures dwindled during the depression years, and during the period 1935–36 were expected to be in the neighbourhood of 11,000,000.

EXPERIMENTS are being carried out in the United States on a process of removing excess water from freshly placed concrete. According to the *Engineering News Record*, the process involves the application of a vacuum to the surface of the concrete through the medium of special pads or of special forms. Subjecting slabs of wet concrete to a 20in. vacuum for twenty minutes removes about one-third of the water and renders the concrete stiff enough to walk upon. In addition to its primary function of removing the excess water, the process subjects the concrete to compression from the forms, which are under atmospheric pressure on the outside and a vacuum on the inside. The process, it is claimed, will furnish a completed slab surface, eliminating finishing operations and providing any type of non-skid design desired. The equipment is still undergoing investigation and test, but in principle it consists of a tight outside form, which may be a steel plate or a rubber mat that acts as a seal, and inside layers of wire mesh or porous canvas which will permit the water to be drawn out by the vacuum cups attached over holes in the outside form. Cores and specimen cylinders of "vacuum-compression" concrete have shown seven and twenty-eight-day strengths ranging from 53 to 81 per cent. greater than for similar concrete not treated. Elimination of shrinkage difficulties is another advantage claimed for the method

Air and Water.

THE French Ministry of Marine is to establish a naval base near Oran, Algeria.

THE third 10,000-ton German battleship, the "Admiral Graf Spee," has been placed in service at Wilhelmshaven.

THE Imperial Airways liner "Heracles" has set up a new record of 80 minutes for the 203 miles flight between Paris and Croydon.

A RADIO station for aircraft is to be established at the Baldonnel Aerodrome, Dublin, as a step towards providing a cross-Channel air service to Great Britain.

DURING 1935 there were 376 launches made to vessels in distress by the lifeboat service. This is the largest number of launches made since 1916. The number of lives rescued was 492.

THERE are at present seven British vessels with a total tonnage of 6937 tons laid up at Welsh ports, as compared with twenty-four vessels with a total tonnage of 30,413 tons laid up a year ago.

THE French Air Minister has stated that during the past year forty new civil aerodromes were constructed in France, and that the number of privately owned aeroplanes increased from 1000 to 1200.

THE Cunard White Star 19,761-ton liner "Scythia" has been withdrawn from Atlantic service, and entered in the British troopship fleet. This vessel was built in 1920 and in 1932 carried out tests with colloidal fuel.

THE number of British shipping companies with fleets of more than 50,000 tons gross is sixty-one. The aggregate has declined from 2051 vessels of 12,667,564 tons at the end of 1934 to 2040 vessels of 12,503,162 tons at the close of 1935.

ON December 31st last the Imperial Airways flying boat "City of Khartoum" was lost in the Mediterranean Sea off Alexandria. Twelve of its thirteen occupants lost their lives, the pilot alone being rescued. The cause of the accident has not yet been made known.

THREE new vessels are being built for the Union Steamship Company of New Zealand. The first, a 14,000-ton gross liner, is to be named "Awatea" ; the second, a 3900-ton motorship, "Matua" ; and the third, a 2400-ton motorship, is to be named "Kauri."

THE first of six new coaling plants being erected by the London, Midland and Scottish Railway at Fleetwood has been completed. These six electrically operated belt conveyors, capable of dealing with 20-ton wagons, will replace the present system of bunkering trawlers by means of cranes and buckets.

THE Withernsea lighthouse on the East Yorkshire Coast is to be converted from oil to electric operation. Under the new system the keeper will not have to watch the lamp all night, as when the main lamp fails an alarm rings and a second lamp operating on an independent battery automatically lights up.

WHEN the new destroyer H.M.S. "Griffin" was being towed from Barrow-in-Furness to undergo her trials on the Clyde on January 5th, two of the tow ropes broke and one of the tugs crashed into her side cutting a hole in her plates. The damage is only slight, and the vessel will be fit for her trials in a few days.

THE first section of the new £500,000 dock improvement scheme at Shanghai will be completed in August next. This first section of the dock will consist of two 590ft. wharves, a jetty for tenders and Customs launches, Customs building with baggage examination rooms, rest rooms, a café, and other buildings.

A RECORD total of inward shipping tonnage was received at the Southern Railway Docks at Southampton during 1935. A total of 17,991,539 gross tons entered the port. This exceeds the 1934 total by 8 per cent. Cargo traffic exceeded 1934 figures by over 100,000 tons, while the number of passengers entering and leaving the port rose to more than 530,000.

AN article in *Flight* describes a new Mercedes Benz oil engine of a type which is presumably to be fitted in the new Zeppelin "L Z 129." Known as the "O.F. 2," the engine is of the water-cooled, 60 deg., vee, twelve-cylinder type, the cylinders having a bore of 165 mm. and a stroke of 210 mm. The cruising power is 720 h.p. at 1720 r.p.m., and the full throttle power is 750 h.p. at 1750 r.p.m.

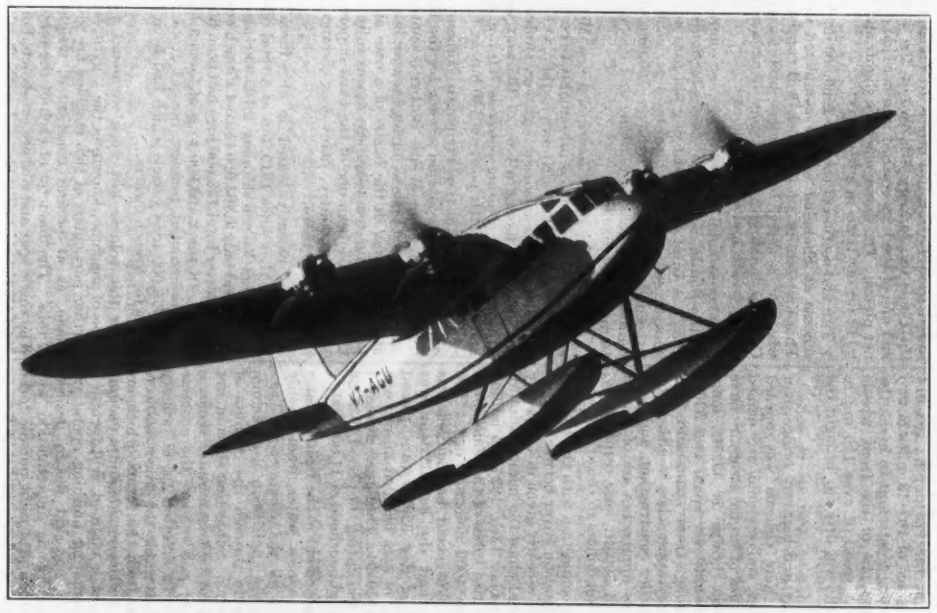
ACCORDING to the Plymouth correspondent of *The Times*, a large expansion scheme for the Royal Air Force flying boat base at Mount Batten is contemplated. The station was first opened during the war, but for a long time afterwards was in the hands of a care and maintenance party. About ten years ago it was fully manned again, and has since been one of the most important flying-boat bases in the country, many long-distance flights having started from there.

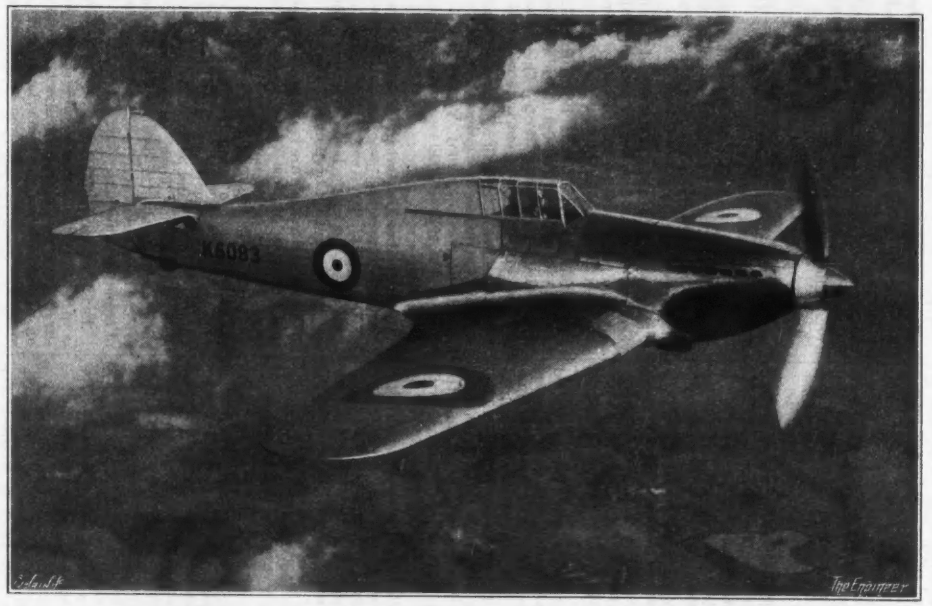
IT was recently stated in the French Chamber of Deputies that since 1919, out of a total of over 4,000,000 tons of new French shipping, 2,160,000 tons were of foreign origin and only 1,862,000 tons of French construction, and of this latter total 732,000 tons had been built for or by the State. Of the 2,160,000 tons of foreign origin, 1,386,000 tons represented tonnage bought from foreign owners and 776,000 tons vessels which had been built in foreign yards for French owners.

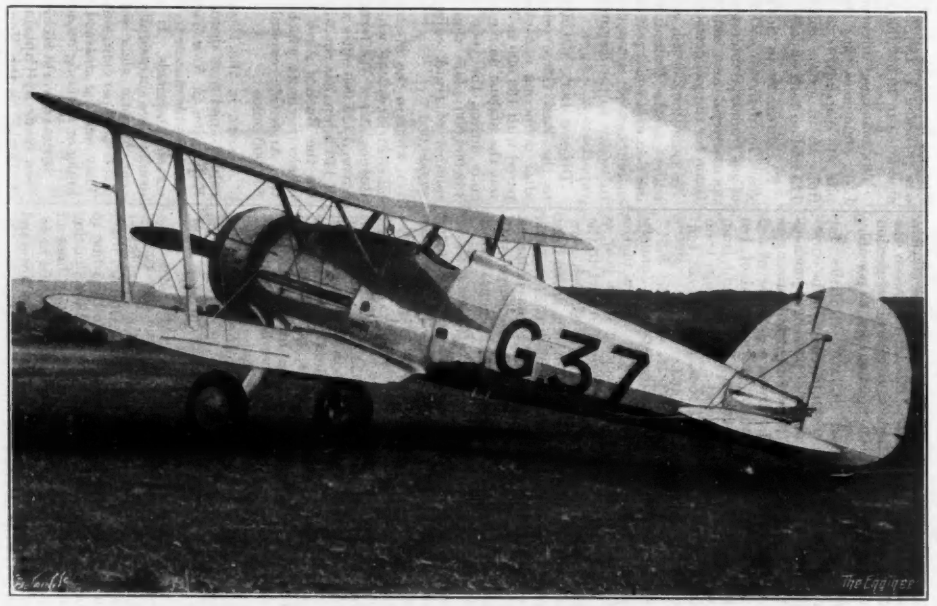
IN this column last week we noted a new helicopter type of machine, known as the "gyroplane." In *Flight* further particulars of this machine are given. The gyroplane, as at present constituted, weighs slightly over 2 tons. The diameter of each of the rotor blades is 52ft. The single spar and ribs are constructed of duralumin, the leading halves being covered with duralumin sheet and remainder fabric covered. A stainless steel sheathing is used to form the leading edge. The total blade surface is 12 square metres, which represents 6 per cent. of the surface swept by the rotors. In the recent trial flights the rotor blades turned at 132 r.p.m., being geared at a ratio of 16·7 to 1. The lift of the machine is 7150 lb. The power unit is an Hispano Suisa nine-cylinder radial air-cooled engine rated at 350 h.p. at 2450 r.p.m.

SOME BRITISH AIRCRAFT OF 1935

(For description see page 49.)







THE SHORT "SCION SENIOR" 10-SEATER SEAPLANE
THE GENERAL AIRCRAFT MONOSPAR "JUBILEE" FIVE-SEATER

THE HAWKER-MERLIN MONOPLANE FIGHTER
THE GLOSTER "GLADIATOR" FOUR-GUN FIGHTER

The Engineer

JANUARY 10, 1936.

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Contents.

THE ENGINEER, January 10th, 1936. PAGE

A SEVEN-DAY JOURNAL ... 33
ROADS, BRIDGES, AND TUNNELS IN 1935. No. II. (Illus.) ... 34
HARBOURS AND WATERWAYS IN 1935. No. II. ... 36
ELECTRICAL ENGINEERING IN 1935. No. II. (Illus.) ... 38
WATER SUPPLY AND SANITARY ENGINEERING IN 1935. No. II. ... 40
THE PHYSICAL SOCIETY'S EXHIBITION. No. I. (Illus.) ... 41
LETTERS TO THE EDITOR—
Trade and Currency Devaluation—Small Scale Tests ... 44
RAIL AND ROAD—MISCELLANEA—AIR AND WATER ... 45
LEADING ARTICLES—
Floods—Road Accidents ... 47
LITERATURE ... 48
BOOKS RECEIVED ... 48
SIXTY YEARS AGO ... 48
AERONAUTICS IN 1935. No. II. (Illus.) ... 49
SHIPBUILDING AND MARINE ENGINEERING IN 1935. No. II. (Illus.) ... 50
A NEW SWITCHGEAR TESTING PLANT. (Illus.) ... 52
AN UNUSUAL ELECTRIC MACHINE DRIVE. (Illus.) ... 53
A 300-TON VARIABLE STROKE PRESS. (Illus.) ... 53
A LARGE INGOT MOULD. (Illus.) ... 53
SCIENTIFIC AND INDUSTRIAL RESEARCH ... 54
A STEAM DIVING BELL BARGE. (Illus.) ... 57
SOUTH AFRICAN ENGINEERING NOTES ... 57
STAINLESS STEEL ... 58
CALENDARS, DIARIES, &c. ... 58
PERSONAL AND BUSINESS ANNOUNCEMENTS ... 58
CONTRACTS AND ORDERS ... 58
CATALOGUES ... 58
MARKETS, NOTES AND NEWS ... 59
CURRENT PRICES FOR METALS AND FUELS ... 60
FRENCH ENGINEERING NOTES ... 61
BRITISH PATENT SPECIFICATIONS. (Illus.) ... 61
FORTHCOMING ENGAGEMENTS ... 62
LAUNCHES AND TRIAL TRIPS ... 62

NOTICES TO READERS.

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CHANGES OF ADDRESS.

*** *Will subscribers please note that in al advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

FLOODS.

THE recent floods in this country, and especially in the Thames Valley, have called attention to an aspect of river conservancy work which claims the interest of the public at fairly frequent intervals. The floods which ushered in the New Year were widespread. Besides the affected districts in the Thames Valley in Oxfordshire, Reading, Maidenhead, and Windsor, parts of Kent and Sussex were inundated, the waters were out below the East Yorkshire Wolds, and in the East Midlands, and the threat of flood, if not the actual fact, existed in the Eastern Counties and the Fens. But, despite references in the daily Press to the "menace" of the floods, the result was less dangerous than inconvenient. It may be doubted, in fact, whether the floods would have received so much publicity were not the banks of some rivers in low-lying areas built upon. A certain amount of farming stock was, perhaps, placed in peril. Houses were invaded and in some cases occupants rendered temporarily homeless. Traffic was held up and delayed. In some districts the invasion of factory buildings may have hindered the carrying out of the daily work. But there was not, and there could not be, any of the devastation that accompanies a high flood on such great rivers as the Ganges or the Indus, or which follows upon the catastrophic bursting of a dam.

To the conservators of most of the affected rivers in this country the occurrence of the floods can only have been remarkable in that they followed closely upon a period of drought extending over three summers and leading to such a deficiency of rainfall that, in the Thames Valley at least, an unprecedently wet autumn has not yet made it up. During the three months, September, October, November, no less than 13·96in. of rain fell in the Thames Valley. Yet, since floods arise only from the concentration of heavy rainfall into comparatively few days, the resulting flow reached only about 6000 million gallons per day over Teddington Weir, and, indeed, following upon a dry beginning to December, the flow just before Christmas was only 1700 million gallons per day as compared with a "bank-high" condition of 4500 million gallons. The cause of the floods lay in the fact that in eleven days up to January 2nd of this year, 2·71in. of rain fell, and as a consequence the river rose rapidly until it was discharging at a maximum rate on January 3rd of approximately 9000 million gallons a day. Even at that figure—just twice the quantity the river can discharge without overflowing its banks—the flood was by no means a very heavy one. It was less important than the comparable flow in December, 1929, when a maximum of 10,489 million gallons per day passed over Teddington weir, and it was small as compared with the almost unprecedented flood of 1894, when it was estimated that the flow reached a rate of 20,000 million gallons a day as a result of quite exceptionally heavy rainfall conditions occurring at a time when the river was already in flood. To the Conservators, indeed, the recent floods were quite unexceptional and demanded the taking of no special measures other than those which are always put into force when rivers threaten to overtop their banks. The rivers were, of course, watched and the flows and levels at various points measured for record purposes. In some places the watch may have been more vigilant or the measurements more carefully carried out so that the success or otherwise of any new work could be gauged. But, on the whole, the circumstances were to the Conservators hardly unusual.

But to those who suffered either directly by the invasion of their homes or indirectly by the delay and hindrance to their business arising from the dislocation of traffic, it is small comfort to learn that the floods were not exceptional. Much can be done, and is being done, to relieve floods or prevent their occurrence. On the Thames there was recently opened the Desborough Cut, forming part of the Thames Improvement Scheme from Shepperton to Teddington, which is known to have had a material effect upon the river levels throughout this length. Much work has been carried out by the River Trent Catchment Board, abstracts from the report of which for 1934 we published during the past year. The Ouse Catchment Board has a scheme in hand in South Yorkshire to cost £1,190,000, and the Somerset Catchment Board is considering the expenditure of £545,000 on various works. With the recent offer by the Government of a 60 per cent. grant to approved schemes in the Special Areas the construction of flood-prevention works is likely to be accelerated. But no hope can be held out that low-lying areas will ever be permanently freed from the threat of flood. Provision, except at an impossibly uneconomic cost, cannot be made for exceptional outbreaks. In 1914 a report was issued on the prevention of floods in the Thames Valley, in which it was suggested that works should be carried out sufficient to give the river the capacity to discharge 7000 to 8000 million gallons a day when flowing bank-high. That scheme, involving works not extensive enough even to prevent a quite normal flood such as that recently experienced, was estimated to cost £3,000,000 in 1914, and would involve a much greater expenditure to-day. What can be done, however, and what is now being done by the suitable improvement of rivers throughout the country, is to prevent any but very heavy floods invading highly populous and industrial districts and to limit them harmlessly to wide, low-lying areas of grass and arable land, which, besides forming the natural flood channels for the discharge of excess water, are also likely to benefit in fertility from the inundation.

Road Accidents.

As a result of the commendably rapid issue of provisional figures of road accidents in this country during 1935 by the Ministry of Transport it is possible at this early date to make comparisons between the year just passed and those that preceded it and to estimate thereby to what extent the measures adopted to bring the "toll of the road" under control have been successful. The comparison, while it can lead to no feeling of complacency, is by no means unsatisfactory, for it shows that definite progress has been made. It is the more gratifying in that the conditions requiring control are very complex and difficult to separate into distinct and disconnected groups which might be dealt with in detail. Briefly, 6521 people were killed and 218,798 injured on the roads of England, Scotland, and Wales in 1935, as compared with corresponding figures of 7343 and 231,603 respectively in 1934. This comparison, satisfactory in itself, is rendered even more so when it is further realised that a considerably greater number of vehicles was using the roads during the year just concluded. Moreover, it may be hoped that since the proportion of deaths to injuries fell the extent of injury in each case was less than in the previous year. According to figures given in Mr. Hore-Belisha's broadcast speech on January 2nd, 87 persons were killed or injured for every thousand vehicles in 1935, as against 99 persons per thousand vehicles in 1934.

Much of the improvement recorded may, we believe, be traced indirectly to the effect of collecting statistics of accidents in the manner for which we pleaded in a leader two years ago. These statistics, despite their imperfections, have revealed as nothing else could have done the extent of the perils of the road. They have served to show which classes of road user are the chief sufferers and have helped to demonstrate when improvement has taken place, and against which point the next attack should be directed. When the method has been carried out in greater detail it has shown itself capable of revealing how certain streets are more dangerous than others, and has consequently suggested means whereby those and other streets may be rendered safer. With even greater force, however, statistics demonstrate that it is just in the human psychology element that danger lies most potently. Some lack of foresight, some careless action, or some unexpected motion of a vehicle or pedestrian can transform a street which seemed a moment before free from danger, or even the threat of danger, into a place of mortal peril. Each user of the road, it seems, is willing to incur a certain level of risk. Thus, on a road perfectly safe for a speed of 30 m.p.h. the motorist feels himself impelled to travel at 40 m.p.h. Pedestrians, despite clear indications from signals, still prefer to thread their way through moving vehicles. Cyclists, depending on superior manœuvrability, swing suddenly into or out of side streets. In part at least the credit for future reductions in the number of accidents must lie with the education of children at their schools and of their parents by persistent propaganda. The saddest part of the record is that the chief pedestrian sufferers are children who have not had the time to learn by experience, and the aged brought up in a more leisured period.

While, as we have said, the reduction in the figures can be regarded with satisfaction, it is totally insufficient to justify a complacent frame of mind. A figure of 14·36 persons killed per 100,000 of the population per year cannot be tolerated when everyone feels that it is reducible. When there is a multitude of small units on the road, each under the individual control of a by no means infallible human mind, there must inevitably be accidents and fatalities. But, nevertheless, much can be done and should be done as rapidly as possible to make the consequences of any error of human judgment less disastrous. With this aspect of the problem engineers are particularly concerned. By the careful design of new roads and reconstruction of old many of the dangers can be eliminated and the consequences of errors of judgment made less serious. Arterial roads with separate tracks for "up" and "down" traffic, for instance, eliminate the possibility of head-on collision. Roundabouts and swan-neck approaches, which necessarily cause traffic to slow down on its approach to an intersection, restrict, if they do not make impossible, accidents at such places. The adjustment of the camber at corners encourages motorists to remain on the left of the road when swinging right, while good "sandpaper" road surfaces, freeing the driver from the fear of skids, give him the confidence so necessary if accident is to be avoided. By the provision of a separate track the cyclist can be separated from the stream of faster-moving vehicles and thus be removed from the possibility of accident except with his fellows. But it is in the busy thoroughfares of cities that the engineer can be most usefully employed to increase safety. Here the protection of the pedestrian, of whom 3080 were killed and 74,095 injured in 1935, is the most urgent problem. Perhaps it will be partly solved by the increased use of traffic light installations, of which there were 528 in operation in London during some part of 1935, and their modification to give to the pedestrian a clearer indication of when it is safe to cross. The extension of the use of pedestrian railings to whole streets, while limiting an ancient right of use of the King's highway, may well bring forth a great increase of safety. In the further application and development of the vapour lamp, which,

lighting the streets on a principle of reflection from the surface, leaves no "pools of darkness," lies a further hope—a hope which could be rendered more certain of fulfilment were it possible to reduce the fatiguing glare from the unshaded lamps. But these improvements in detail of city streets are, to a great extent, only palliative. Sooner or later, as the density of traffic increases, it will be necessary to widen or re-design existing streets or to build new thoroughfares. When projects of this nature are carried out the success or failure of the engineer will be judged by the safety or the lack of safety with which traffic, both pedestrian and vehicular, can use those streets. The ideal street would be one the design of which was such that accidents, despite occasional human failure, could not happen. Surely it is not beyond the ingenuity of engineers to approach so close to this ideal that no accident, if it should occur, could be of a serious nature?

Literature.

Fuel. Fourth edition. By J. S. S. BRAME and J. G. KING. London: Edward Arnold and Co. 1935. Price 25s. net.

Liquid Fuels. By HAROLD MOORE. London: Technical Press, Ltd. 1935. Price 21s. net.

THE subject of fuels is still of pre-eminent importance to industry. It is ever-changing as the engineer makes new inventions involving the use of new types. At one time fuel meant wood when the forests of Sussex and of other shires were cut down to meet the needs of the Wealden ironmasters; later, "sea-coale," water-borne from Newcastle, replaced the wood; and in due time the iron industry went North to be near the coalfields. Shipbuilding and the heavy industries were also established near the coal, and it arose that much of Britain's prosperity was founded on cheap coal. The collieries near the ports were able to produce at a price that enabled their coal to be transported all over the world in British ships, and both coal and shipping had many years of prosperity.

Coal was cheap and everybody used it carelessly. Few subjects were more neglected in, say, 1900 than fuel economy. Disastrous strikes, involving the cutting off of supplies and a great increase in the price of fuel, forced the idea of economy in the use of coal to the fore, with the result that for a given object the quantity of fuel required has been halved and is in process of being halved again; there is depression in the coalfields.

The engineer invented the internal combustion engine; the motor car, and the oil engine and the oil-fired boiler have become actualities, and petroleum, which is so cheaply brought to the surface, has become "oil," a word of significance. The light fractions used to be wasted; now every means is sought to increase their proportion; the middle fractions are Diesel oil and fuel oil, and the heavy ends lubricating oil. There is a use for every drop of the oil. The engineer has devised methods of cheap, long-distance transport for oil; pipe lines carry it across the arid desert, oil tankers across the seven seas.

Another fuel is gas—in Europe made from coal, in America a natural product in almost inexhaustible quantity. Gas, at first invented as a means of lighting instead of candles and paraffin lamps, is the ideal source of heat for domestic purposes in cities. It is on tap in every room, the householder keeps no stocks, has no refuse to dispose of.

There is intense competition between the three types of fuel in almost every field of their application, and, perhaps in consequence of this, a great impetus has been given to their economic utilisation and to knowing something about them—a subject in which, on the whole, we have been strangely backward.

The two books before us are both suited either for the engineer, for the fuel chemist, or the works manager. Messrs. Brame and King cover all three types of fuel; Harold Moore confines himself to liquid fuels. Had Britain been blessed with supplies of petroleum and natural gas, it is probable that their use would be almost universal to-day. As it is, they menace the coal industry in many respects, particularly where its inefficiencies are manifest. It would be well if someone could bring home to both mineowners and miners the dire consequences of another stoppage or of a substantial price increase in giving an impetus to the further use of oil and to greater economy in the burning of coal. Our authors are not concerned with the economies or the politics of the subject, but they do give chapter and verse showing how to effect these economies.

Both books deal in detail with fuel analysis, which is an important subject for the buyer, and enters into the control of combustion by the user. The use of recording instruments of all kinds has greatly facilitated this type of control; indeed, it can be stated with confidence that no fuel installation can afford to economise on instruments.

Brame and King, whose book has now come of age, discuss coal and coke under the accepted headings, which hardly need detailed comment more than to say that every aspect of the subject is adequately treated. Useful chapters are that on the commercial varieties of coal and another on its preparation for the market, washing, and storage.

Coke is increasing in importance as a fuel, perhaps because its quality is so much better and more uniform than in the past—both the gas and coke oven industries are taking more pains in this respect.

Low-temperature fuels are likewise discussed, as is powdered coal and coal-oil suspensions or emulsions. These are subjects in which the last word has not yet been said; indeed, such processes may easily become economic and important at any moment.

A great deal about liquid fuels is condensed into a few pages. The gas section has to include coke oven, producer, blast-furnace, and water gas, as well as the variety made at a gasworks.

The book, whilst comprehensive, is clear and contains much information in a limited compass.

Harold Moore's treatise is confined to liquid fuels, and likewise contains a store of information relating to them and their uses.

There are two substitutes for natural oils—the benzol and tars produced from coal and ethyl alcohol made by fermentation from molasses. Both of these are competitive with coal, though they are purely additive in the economic sense. They do, however, represent a local production of liquid fuel in countries where there is no natural petroleum.

Either or both books will form a useful addition to the engineer's library.

Jane's Fighting Ships, 1935. Edited by FRANCIS E. MCMURTRIE, A.I.N.A. London: Sampson Low, Marston and Co., Ltd. 42s. net.

THE thirty-ninth issue of this pictorial encyclopedia of the world's navies makes a timely appearance at a juncture when events at home and abroad are focussing attention on the political significance of sea power. This is the first edition to be prepared by Mr. F. E. McMurtrie in his capacity as editor, and we congratulate him on the result of his labours. As is noted in the Foreword, the work has been attended with certain difficulties. "Owing to the international situation existing during the greater part of 1935, it has been far from easy to secure information concerning new ships or the reconstruction of old ones. But a large variety of new material has been incorporated, with the result that the present issue is at the moment the most complete and up-to-date record of the world's war fleets in existence." That claim is fully justified. The navies of nearly fifty states are described and illustrated in detail, the data in some cases having been checked down to November last, and there are several photographs of new ships fresh from the building yard. Care has obviously been taken to avoid the smallest inaccuracy, and a wise restraint is exercised in forecasting the characteristics of vessels not yet completed. As a result, those who consult this book may feel confident that the information it contains is to be relied upon. The sections which have a special topical interest are the British, French, Italian, German, United States, and Japanese. Each has been enriched by new photographs, diagrams, and silhouettes, and the explanatory figures and text bear evidence of scrupulous revision. Official details are given of the German battleships, cruisers, &c., now building, together with photographs of the first "pocket" submarines. The Italian naval section is admirably complete. It will be observed with interest that Italy, despite her expressed sympathy with the principle of abolishing submarines, laid down a dozen more of these boats last year and will soon possess an underwater flotilla second in numerical strength only to that of France. The growing power of the Japanese Navy is exemplified chiefly by the steady increase in those light forces, both surface and submarine, which could be employed with telling effect in the western sector of the Pacific. It needs but an elementary grasp of the logistics of strategy and tactics to discover that Japan already is in à position to defend herself against any conceivable attack from the sea. It would be superfluous to recommend "Fighting Ships" to students of naval affairs. We will only add, therefore, that the 1935 edition is fully up to the standard set by previous issues, and is, indeed, a production of which editor and publishers have every reason to be proud.

BOOKS RECEIVED.

The Metal—Iron. By H. E. Cleaves and J. G. Thompson. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 36s. net.

Engineering Factors in the Ventilation of Metal Mines By E. C. McElroy. Washington: United States Government Printing Office. Price 25 c. net.

Steam Turbines. Second edition. By E. F. Church. London: McGraw Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 18s. net.

Reducing of Industrial Power Costs. By D. M. Myers. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 24s. net.

The South and East African Year Book and Guide, 1936. London: Union Castle Steamship Company, Ltd., 3, Fenchurch-street, E.C.3. Price 2s. 6d. net.

Stratosphere and Rocket Flight (Astronautics). Second edition. By C. G. Philp. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, W.C.2. Price 3s. 6d. net.

Statistical Appendix to Minerals Year Book, 1934. Edited by O. Kiessling. Washington: United States Government Printing Office. Price 1·00 dollar net.

The Preparation of Engineering Reports. By T. R. Agg and W. L. Foster. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 10s. 6d. net.

Symposium on the Welding of Iron and Steel, 1935. Two volumes. London: The Iron and Steel Institute, 28, Victoria-street, S.W.1. Price £2 2s. net the two volumes.

Technical Data on Fuel. Fourth edition. By H. M. Spiers, M.A. London: The British National Committee, World Power Conference, 36, Kingsway, W.C.2. Price 12s. 6d. net.

Practical Boiler Firing. By H. C. Armstrong, M. Inst. C.E., and C. V. Lewis, M.I. Mar. E. London: Charles Griffin and Co., Ltd., 42, Drury-lane, W.C.2. Price 4s. net.

Guide to the Unemployment Insurance Acts. Fourth edition. By H. C. Emmerson, M.A., and E. C. P. Lascelles. London: Longmans, Green and Co., Ltd., 39, Paternoster-row, E.C.4. Price 6s. net.

Modern Uses of Nonferrous Metals. Edited by C. H. Mathewson. New York: American Institute of Mining and Metallurgical Engineers, 29, West Thirty-ninth-street, N.Y. Price 3·00 dollars net

The "Practical Engineer" Mechanical Pocket Book and Diary, 1936. Edited by E. G. Beck, A.M. Inst. C.E. London: Oxford University Press, Amen House, Warwick-square, E.C.4. Price 2s. 6d. net.

High-speed Diesel Engines, with Special Reference to Automobile and Aircraft Types. Second edition. By A. W. Judge. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 15s. net.

General Foundry Practice. By the late A. McWilliam and P. Longmuir, D.Met. Fourth edition, revised and enlarged by P. Longmuir, D.Met. London: Chas. Griffin and Co., Ltd., 42, Drury-lane, W.C.2. Price 21s. net.

SIXTY YEARS AGO.

ONE does not ordinarily associate the risk of fire with a salt mine. It was therefore with some mild interest that we began to read an account of one such fire which appeared in our issue of January 14th 1876. It was, however, soon borne in upon us that there was more than mild interest in the article and that it was really the chronicle of a series of mishaps, all unnecessary, which had piled one upon another with the grimness of a Greek tragedy. . . . At the Government rock salt mines at Brochnia, Galicia, a steam engine was situated at the 1000ft. level. It was fed with steam from a boiler at a higher level and drew salt up an incline from lower levels. On December 30th 1875 there was no work for the engine to do and a youth was told to clean it. While he was carrying out his task some cotton waste caught fire from a pit lamp. He extinguished it, as he thought, and returned what he had managed to save to a chest containing clean waste, rape oil and tallow. Returning to the shaft he told a miner of the incident. This man realising the possibility of danger hurried to the spot but before he could reach it the chest was well alight and the flames had spread to the mine timbers. He raised the alarm and all the 200 miners except three left the workings in safety. Those three it was learned afterwards had been caught in the lower levels and suffocated. Unaware of their fate, the mine officials sent three men down to look for their comrades. They never returned. Caught doubtlessly in the vitiated atmosphere, they perished as had those whom they sought. When it became clear that all six men could not be recovered alive steps were taken to stop the spread of the fire by building walls of salt across the heading. Four days later an inspector of mines and the manager accompanied by two workmen descended the mine to investigate the cause of the accident and to devise additional means of preventing farther damage. They could not be persuaded to postpone their investigation until assurance was forthcoming that the mine was free from foul air. In due time those on the surface received the signal that the party had arrived safely below. It was afterwards supposed that the inspector and the two workmen left the cage to explore the workings, the manager remaining behind to operate the signals. Apparently the three men feeling themselves being overcome by the fumes managed to rejoin their companion and all entered the cage. Those on the surface heard a faint signal which they interpreted as an instruction to hoist. The engine was started but after a few turns a stoppage occurred below, the cage having apparently encountered some obstacle. Increased efforts were applied to raise it but they were fruitless. Another party of four men volunteered to descend by a second cage. Precautions, previously neglected, were taken on this occasion. The party descended from level to level opening the headings as they proceeded in order to allow an influx of fresh air. Eventually the bottom of the shaft was reached. What had happened became painfully clear. The previous party before giving the signal to hoist had forgotten or been too faint to close the bar of the cage. The bar, catching the first projection which it met, had tilted the cage and the occupants had been thrown out into the sump. Thus perished ten men through the folly of one youth.

Aeronautics in 1935.

No. II.

(*Concluded from page 4, January 3rd.*)

WE conclude below our account of the activities of representative British aircraft builders during 1935, and append a few notes on engine developments.

Hawker Aircraft, Ltd.—The Hawker Aircraft Company and its associate the Gloster Aircraft Company were very busy during the year. Considerable factory and aerodrome extensions were undertaken to facilitate an increased output. At the Hawker works aircraft of the "Audax," "Demon," "Fury," "Nimrod," and "Osprey" types continued to be produced while the "Hind" an improved day bomber with a Rolls-Royce "Kestrel" engine is on the point of being delivered to R.A.F. squadrons. On the experimental side a new fighting monoplane equipped with a Rolls-Royce "Merlin" engine was built. This machine illustrated on page 46 is now undergoing flight trials, the results of which are stated to be in excess of anticipation. It is of metal construction with fabric covering and has a retractable undercarriage. The machine is obviously a remarkable one but concerning its characteristics and details nothing may at present be disclosed. Foreign comment upon it implies that its engine develops over 1000 h.p. and is cooled by ethyl-glycol. It has been described by a French critic as an experimental speed machine rather than a true military aircraft, as being too heavy to be manœuvrable and as being too powerful to have the range required to establish contact with an enemy. All such criticism must, however, at this stage be founded on guesswork. That the speed is high is certain. There are in fact good grounds for believing that it is over 300 m.p.h. The Gloster works were engaged on the execution of very large orders for "Gauntlet" aircraft, general purpose single-seater fighters to which we have made reference on previous occasions. Trials were completed and production was begun of a four-gun fighter known as the "Gladiator." This machine, illustrated on page 46, is driven by a Bristol "Mercury" engine. It is stated to have a top speed of 260 m.p.h. and a landing speed of 57 m.p.h. It is of metal construction with fabric covering. One may perhaps be forgiven for speculating whether this machine—and others of the same general design now in existence—represents approximately the limit of performance to which it is possible to go with aircraft of its type and whether in the Hawker-Merlin monoplane fighter we may not see the coming of the new era at which we hinted in the introduction to our first article.

Short Brothers, Ltd.—At the Rochester works activity was chiefly concentrated on the production of a number of "Singapore" III flying boats for the Air Ministry for service at Basra, and Singapore and in the Mediterranean. The work in hand includes the fleet of flying boats for Imperial Airways to which reference was made in the first part of this article. These aircraft will be high-wing monoplanes driven by four Bristol "Pegasus" or "Perseus" engines fitted with controllable pitch air screws. They will have a span of 114ft. and an overall length of 88ft. Their fully laden weight will be about 39,000 lb. As already noted they will provide accommodation for twenty-four day passengers or sixteen night passengers, in addition to a considerable mail capacity. The hull will contain two decks. The upper deck forward will be devoted to the crew and mails. One of these aircraft or a machine similar to them will form the lower component of the Mayo composite aircraft, which, as previously noted, the company is building for Imperial Airways.

The design of the company's civil machine known as the "Scion" has been described and illustrated in previous reviews. During the year the production of this machine was taken over by Pobjoy Airmotors and Aircraft, Ltd. A development of the type, known as the "Scion Senior" was produced during the year and is illustrated on page 46. Two of these aircraft have been built to the order of the Irrawaddy Flotilla Company. The machine, except for certain minor fittings and the coverings, is built entirely of metal, the fuselage frame being of welded high-tensile steel tubing and the wing and tail unit structure being of duralumin. Four Pobjoy "Niagara" engines each developing normally 84 b.h.p. at 3200 r.p.m. are carried on the leading edge of the wings. Each engine is fed by its own pump from one of two tanks embodied in the wings. If the pump of one engine fails the supply is automatically continued by the pump of one of the others, each pump having a capacity more than sufficient for two engines. The pilot is situated in an enclosed cock pit, with a sliding roof and opening side windows, at the extreme nose of the fuselage. Behind him the cabin provides seating accommodation for nine passengers. It also contains a lavatory and luggage compartment. As a seaplane the machine has a fully laden weight, without pilot, passengers and baggage, of 4563 lb. and a cruising speed of 121 m.p.h. It can also be arranged as a land plane in which form its fully laden weight is 4191 lb. and its cruising speed 127 m.p.h. In both forms it can climb on three engines. As a land plane it can climb very slowly on two engines but as a seaplane it just fails to climb in this condition.

The Blackburn Aeroplane and Motor Company, Ltd.—The "Shark" general-purpose coastal protection two or three-seater which we illustrated a year ago was in production at the Brough works during the year. It has now been fitted with a "Tiger" VI engine of 820 b.h.p. and its structural strength has been increased. "Shark" aeroplanes were produced for the R.A.F. and the Portuguese Naval Air Service and recently an order was received from the Canadian Government for four machines of the same design fitted with both wheel and float undercarriages. Among the experimental work undertaken by the company is the fitting of Napier "Culverin" compression-ignition engines in an "Iris" flying boat. The pressure of work on the military side handicapped the company's production of civil machines. A new commercial aeroplane is however under construction. This machine is designed to carry ten persons at a maximum speed of over 200 m.p.h. It will be fitted with a new type of single spar wing and with a retractable undercarriage and tail wheel. The pressure of work also had another reaction on the company's activities. It may be recalled that it began operations early in 1914 at Leeds and that some years ago it transferred its works to Brough on the Yorkshire coast, the removal being completed in 1929. To relieve the pressure on the Brough works the company has now reopened the old Olympia factory at Leeds. It is also interesting to note that it is planning to establish another factory on the West Coast for the construction of large long-distance flying boats. The Brough School of Flying which is operated by the company was busy throughout the year, and had to be enlarged to accommodate the influx of new pilots the preliminary training of whom under the Air Ministry's expansion scheme has been entrusted to civil schools. The engine factory operated by the Cirrus Hermes Engineering Company which was transferred from Croydon to Brough when the Cirrus Company was taken under the control of the Blackburn Company in 1934 was employed on the production of "Hermes" IV A engines and on the development of two new types of "Cirrus" engines.

General Aircraft, Ltd.—The General Aircraft Company's works are situated at Feltham, Middlesex, and are identified with the construction of machines on the "Monospar" system. During the year the company produced a new design, the "Jubilee" Monospar, a five-seater, twin-engined, low-wing, cabin monoplane, which is illustrated on page 46. The wings are constructed with single spars, of metal, instead of the usual front and rear spar. The spars of the two wings are not however continuous across the fuselage but are jointed thereto in order that the wings may be folded for storage purposes. Inside the cabin the seats are arranged in two side-by-side pairs with a fifth one behind. The space occupied by the fifth seat may quickly be converted into a luggage compartment which is accessible through a separate outside door. Either of the occupants of the front pair of seats may pilot the machine, the control wheel being to that end mounted to throw over from one side to the other. The engines are two Pobjoy "Niagara" II motors of 84 b.h.p. each. With 38 gallons of fuel and 4 gallons of oil and allowing 800 lb. for the pilot and passengers the machine has a fully laden weight of 2875 lb. At 77 per cent. of the engine power the cruising speed at sea level is 123 m.p.h. and the range 520 miles. It is claimed for the machine that it is the first to be sold to the purchaser with all the requisite equipment included in the purchase price. The equipment is certainly very complete. It includes hydraulic wheel brakes, engine starters operated from within the cabin, a dipping landing head lamp, controlled ventilation and heating, all the usual instruments and a radio receiving set. The last-named item may be used for the reception of broadcast programmes or as a "homing" indicator by means of which the pilot may direct his flight towards any selected broadcasting station. In the near future the company will have ready a new design of machine a twelve-seater, low-wing transport monoplane driven by two 450 h.p. "Wasp Junior" engines and possessing a cruising speed in excess of 170 m.p.h.

Other Manufacturers.—Vickers (Aviation) Ltd. at Weybridge confined their production activities practically to the requirements of the Royal Air Force. A new design of monoplane known as the "Wellesley" was produced and an order for it was received from the Air Ministry. This machine of which an illustration is given herewith is driven by a Bristol "Pegasus" engine and is understood to be a two-seater general-purpose aircraft. The absence of an axle to the undercarriage suggests that torpedo carrying may be included among its duties. At the company's Supermarine Works at Southampton flying boats of the "Seagull" and "Scapa" designs were produced for the Royal Air Force and the Fleet Air Arm. The output also included a new design of flying boat known as the "Stranraer," an open sea, reconnaissance machine driven by two "Pegasus" engines. . . . The British Aircraft Manufacturing Company Ltd. of Feltham took over the works and interests of the British Klemm Aeroplane Company in April and considerably extended the production of "Eagle" and "Swallow" machines to which we referred in our review a year ago. The "Eagle" has been improved in several respects notably in the arrangement made to prevent all possibility of a landing being attempted with the undercarriage in the retracted position. In the earlier design an indicator near the throttle control served to warn the pilot that the undercarriage was retracted. As now arranged a chain and sprocket mechanism is interconnected in such a way with the throttle that the pilot cannot fully throttle back the engine until the undercarriage is in the down position. The "Eagle" during the year had some outstanding performances to its credit including a passage of 2000 miles across the South Atlantic in 16 h. 40 min. The company is now preparing to produce two new designs, the "Cupid" a side-by-side two-seater, low-wing monoplane and the "Double Eagle" a high-performance twin-engined monoplane with accommodation for six persons. . . . Airspeed Ltd. of Portsmouth, a company now amalgamated with Swan Hunter and Wigham Richardson Ltd. continued to produce the "Envoy" and "Courier" designs to which we have referred on previous occasions. It will shortly have ready a new version of the "Envoy." This machine will have a considerably increased payload and will be fitted with flap gear for the purpose of reducing the landing speed. . . . The Percival Aircraft Company in addition to the "Gull" and "Mew Gull" machines to which we referred last year produced the "Vega Gull" a four-seater cabin

THE VICKERS "WELLESLEY" GENERAL PURPOSE MONOPLANE

monoplane with dual control. This machine is driven by a "Gipsy" VI engine of 200 h.p. and has a cruising speed of 150 m.p.h. Flaps are fitted to the trailing edge of the wings and by their use the landing speed can be reduced to 44 m.p.h. In addition wheel brakes are provided and as a consequence the machine can be landed in a very small space. Machines of the company's manufacture were supplied during the year to Australia, South Africa, India, Egypt, France and Sweden and work is now in progress on a batch for the Emperor of Abyssinia. "Gull" and "Mew Gull" machines during the year gave a good account of themselves on several occasions. A "Gull" of standard design flew in June from London to Oran in Africa and back again in a total elapsed time of 16 h. 50 min. including a stop of 2½ hours at Oran. In September a "Mew Gull" entered for the King's Cup Air Race averaged a speed of 208·9 m.p.h. over the whole course, the highest speed ever achieved in the race. Later in the year a "Gull" flew from West Africa to Brazil, a distance of about 2000 miles in 13 h. 15 min.

AERO-ENGINES.

There is less to report concerning the development of aircraft engines in 1935 than there was concerning their development in 1934. It is not however to be supposed that there was any slackening of that development. The inference is rather that it reached a stage at which an increased degree of secrecy became desirable. There has certainly been no pause in the efforts made to produce engines of increased power. The aircraft designer is still insatiated as regards the power which he can use in a single unit. In spite of the clearly recognised advantages of multi-engined aircraft it is probable that for military purposes the single-engined machine will always be preferred for fighters, fast day bombers and several other classes.

Aero-engines developing up to 1000 h.p. have been produced in previous years but we believe without exception none of the designs was perpetuated. If rumour speaks truly the Rolls-Royce "Merlin" engine as fitted in the Hawker monoplane single-seater fighter is a motor coming within this category. Its performance will be watched with keen interest for if it is successful it will probably create a demand for still more powerful engines. No limit can yet be placed on the size of engine which might usefully be employed. In responsible quarters discussion has taken place regarding the development of very large aircraft. The possibility has been mentioned of building a flying boat having a total weight of 200 tons. Such a boat would require six or eight air-screws, each driven by an engine or engines developing about 5000 h.p. It has not yet been decided whether such power is better generated by a single unit than by a number of units grouped round a common shaft. The second-named alternative is possible at the present moment. The first is not but doubtlessly if it can be proved to possess considerable advantages it will in due time be made practicable.

It might appear that the compression ignition engine would promise to be the most hopeful direction in which to seek units of increased power. At present, so far as authentic information extends, we have in this country the Bristol "Phœnix" air-cooled compression ignition engine of 350 b.h.p., the Napier "Cutlass" water-cooled, of 535 b.h.p. and the Napier "Culverin" water cooled of 730 b.h.p. Experimental work is being carried out by others, in particular by Mr. H. R. Ricardo who, working on behalf of the Air Ministry on a two-cycle, sleeve valve compression ignition engine, has developed a single-cylinder unit giving an output of 32 h.p. per litre. The development of the compression ignition engine is, however, still suffering from the continued progress of the petrol engine so much so that the superior efficiency of the compression ignition engine is now by itself scarcely sufficient to justify its adoption in preference to the petrol engine. For a time it seemed likely that the compression ignition engine would be regarded with favour because it was free from a very real source of danger and trouble found in the petrol engine, the icing of the carburetter resulting from the joint effect of a low atmospheric temperature and the cooling caused by the evaporation of the petrol. To overcome this difficulty in the petrol engine attention has been directed to the possibility of employing direct petrol injection instead of its atomisation in a carburetter. Good results are understood to have been achieved, but meanwhile an alternative solution of the problem of even greater promise has been found. The formation of ice in a carburetter, it has been discovered, can be prevented if a little alcohol is mixed with the petrol. The continuous addition of alcohol whether the circumstances require it or not is, however, objectionable because it introduces corrosion and other difficulties. An automatic device has, therefore, been produced at the Royal Aircraft Establishment which causes alcohol to be introduced into the float chamber of the carburetter only when freezing conditions are encountered. The automatic action is derived from an ice detector situated in the air intake passage. This detector consists of a small orifice which when it becomes blocked with ice causes the pressure on the two faces of a diaphragm to become unbalanced and the alcohol valve to be opened.

Side by side with this removal of one of the chief operational objections to the petrol engine its fuel economy has recently been greatly increased by the development of automatic mixture control devices which correctly regulate the mixture strength according to the altitude of the flight. Trials extending over three months are stated to have shown a saving of 14 to 30 per cent. of fuel, as compared with the usual manual adjustment of the mixture strength. Another direction in which increased fuel economy is being sought lies in the use of very weak mixtures in conjunction with ignition advance. With some engines, a saving of fuel amounting to as much as 17 per cent. has been indicated as attainable by this procedure.

With these advances in the efficiency and trustworthiness of the petrol engine it would appear that the compression ignition aero-engine in spite of the progress which has been made with it is still at a handicap to its rival.

Shipbuilding & Marine Engineering in 1935

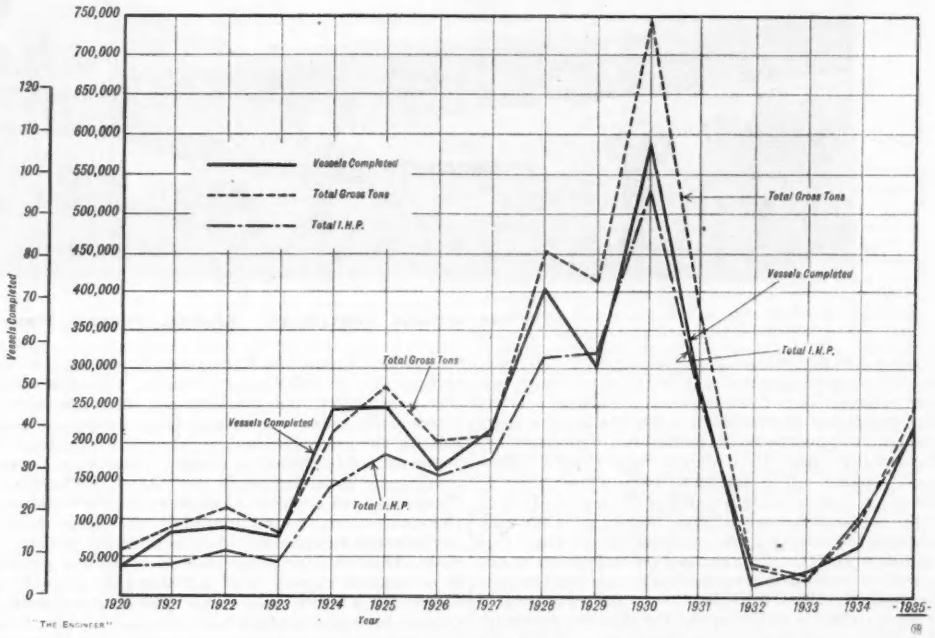
No. II.

(Concluded from page 24, January 3rd.)

IN our last article we dealt generally with the state of the shipbuilding, ship repairing, and marine engineering industry in 1935, and described and illustrated some of the outstanding ships completed. A feature of the year was the large percentage of motor vessels completed and ordered, and in the accompanying curves we show the changes in motor ship construction over the period 1920 to 1935. In 1935 some forty motor ships were completed in British yards, aggregating about 250,000 gross tons, or one-third of the total world construction of motor vessels, while the i.h.p. of engines for these forty ships was close upon 220,000. With a view to showing the comparative degree of standardisation which has taken place in the design and construction of ships of different types we reproduce a table which shows the representative types of liners and cargo ships completed at home and abroad during the period under review. Some of the outputs of the principal British yards are also given below.

Some 1935 Outputs.

Great Britain again held the leading place in world shipbuilding with an output of 290 ships, aggregating over half a million tons, and a million horse-power.



OUTPUTS OF MOTOR SHIP TONNAGE, 1920-1935

She was followed by Germany, then Japan, each with less than half the British outputs. The amount of British tonnage launched fell from 50 per cent. of the world's tonnage in 1934 to about 30 per cent. in 1935. Harland and Wolff, Ltd., of Belfast, Glasgow, and London, was the busiest shipbuilding firm, with an output of 115,306 gross tons and 196,710 i.h.p. This includes the cruiser H.M.S. "Penelope" and passenger and cargo ships along with small craft. The Clyde output was again a high one, totalling seventy-four ships, aggregating close upon 170,000 gross tons and over 410,000 i.h.p. High figures of six ships, representing 29,150 tons, and five ships, aggregating 23,041 tons, were recorded by Lithgows, Ltd., and W. Hamilton and Co., Ltd., of Port Glasgow, respectively. At Whiteinch Barclay, Curle and Co., Ltd., launched three ships of 17,632 tons total and completed engines of 12,370 i.h.p. for four vessels, supplying in addition 5933 h.p. of boilers for other firms. Greenock Dockyard, Ltd., launched two ships, totalling 17,216 tons; while at Govan the Fairfield Shipbuilding and Engineering Company, Ltd., launched five ships of 15,617 tons and built engines and turbines of 82,550 h.p. Other shipbuilding outputs included three ships of 13,884 tons, by Blythswood Shipbuilding Company, Ltd., Scotstoun; three ships of 15,290 tons and 7800 h.p. of engines by D. and W. Henderson and Co., Ltd., of Partick; and four vessels, aggregating 9221 tons with engines of 13,900 h.p., built by Wm. Denny and Brothers, Ltd., of Dumbarton. At Scotstoun Yarrow and Co., Ltd., launched three ships, including the British flotilla leader H.M.S. "Grenville," and two yachts, while machinery of 104,000 h.p. was completed. Among the Clyde engine builders we note machinery for fifteen ships built by David Rowan and Co., Ltd., aggregating 36,550 i.h.p., and eleven additional boilers of 7230 i.h.p. capacity. Seven of these ships were fitted with Rowan-Gotaverken turbo-compressors, and similar installations were supplied to four other ships during the year. At Greenock, John G. Kincaid, Ltd., completed engines totalling 29,650 i.h.p. for six ships; while at Govan British Auxiliaries, Ltd., built Polar oil engine machinery for fifteen vessels, which aggregated 11,470 i.h.p. Among the smaller high-speed oil engines the Bergius Company, Ltd., completed 9216 i.h.p. total and Gleniffer Engines, Ltd., 6090 i.h.p. total. On the East Coast of Scotland noteworthy outputs included nine ships of 25,572 tons, built by the Burntisland Shipbuilding Company, Ltd.; eight vessels, aggregating 5781 tons, by Henry Robb, Ltd., of Leith; and four ships, totalling 4861 tons, by the Caledon Shipbuilding and Engineering Company, Ltd., Dundee.

On the Tyne, Swan, Hunter and Wigham Richardson, Ltd., launched from its Wallsend and Neptune yards 66,811 gross tons and completed 16,800 i.h.p. of machinery, which included oil engines, turbines, and Bauer-Wach low-pressure turbines. The Wallsend Slipway and Engineering Company, Ltd., built three machinery installations, representing 18,400 h.p., and completed 195 oil-burning installations, representing 405,460 h.p. At Hawthorn, Leslie and Co.'s St. Peter's Works oil engine machinery for five vessels, aggregating 16,100 tons, was completed. The North-Eastern Marine Engineering Company, Ltd., of Wallsend-on-Tyne, and Sunderland, supplied 29,093 i.h.p. of engines and turbines and manufactured marine superheaters for 156 boilers, aggregating 174,000 i.h.p. At the Pallion Yard of William Doxford and Sons, Ltd., Sunderland, five standard motor cargo ships were launched, totalling 24,835 tons, and five Doxford opposed-piston engines of welded steel construction, representing a total of 10,500 i.h.p., were built; while at the yard of the Furness Shipbuilding Company, Ltd., Haverton Hill-on-Tees, two ships, a tanker of 7624 tons, and a small cargo steamer were launched. Richardsons, Westgarth and Co., Ltd., built oil engines of 10,000 i.h.p. total for the conversion of two motor ships. Vickers-Armstrongs, Ltd., of

REPRESENTATIVE SHIPS OF 1935

Type of ship and owners.	Name of ship.	Speed, knots.	Shipbuilder.	Hull particulars. Length B.P.	Breadth, moulded.	Depth, moulded.	Gross tonnage.	Type of propelling machinery.	Main engine particulars.
				Ft. in.	Ft. in.	Ft. in.			
British Liners									
The Orient Line ..	"Orion"	21	Vickers-Armstrongs, Ltd.	630 0	82 0	38 0	23,371	Twin-screw Parsons geared turbine with Babcock oil-fired boilers	Four large, two small Babcock-Wilcox, 425 lb., 725 deg. Fah., oil-fired boilers. Twin single-reduction geared turbines, 24,000 s.h.p. total
Peninsular & Oriental Steamship Co.	"Strathmore" ..	21	Vickers-Armstrongs, Ltd.	630 0	82 0	38 0	24,000	Ditto, ditto.	Ditto, ditto.
Melbourne Steamship Co., Ltd.	"Duntroon" ..	17	Swan, Hunter and Wigham Richardson, Ltd.	450 0	65 3	36 0	10,200	Twin-screw Kincaid-B. & W. oil engines	Two six-cyl., two-stroke D.A., 450 mm. bore, 1200 mm. stroke, 7200 b.h.p. total
	"Abosso"	16	Harland and Wolff, Ltd...	457 0	65 0	37 0	11,329	Twin-screw Kincaid-B. & W. oil engines	Two eight-cyl., two-stroke, S.A., 620 mm. stroke, 1150 mm. bore, 7200 b.h.p. total
Bibby Line	"Derbyshire" ..	15	Fairfield Shipbuilding and Engineering Co., Ltd.	482 0	66 0	36 6	11,650	Twin-screw Fairfield-Sulzer oil engines	Two eight-cyl., two-stroke, S.A. engines, 720 mm. bore, 990 mm. stroke, total 8,000 s.h.p.
Foreign Liners									
Compagnie Générale Transatlantique	"Normandie" ..	28½	Penhöet-St. Nazaire ..	962 0	117 9	91 10½	79,280	Quadruple-screw turbo-electric..	Twenty-nine 400 lb., 360 deg. Cent., oil-fired main boilers and four Scotch boilers, four 34,200-kW Alsthom generator sets, and four 238 r.p.m., 40,000 s.h.p. motors
North German Lloyd	"Scharnhorst" ..	20 to 21	Deschimag-Bremen.. ..	610 0	73 10	44 11¼	18,000	Twin-screw A.E.G. Turbo-electric	Four Wagner-Deschimag 711 lb., 470 deg. Cent. oil-fired boilers, and two 10,000-kW generator sets, with two 13,600 s.h.p., 130 r.p.m. motors
	"Potsdam"	20 to 21	Blohm and Voss, Hamburg	610 0	73 10	44 11¼	18,300	Twin-screw Siemens turbo-electric	Four Benson 1280 lb., 480 deg. Cent. oil-fired boilers, two 10,000-kW generator sets, with two 13,000 s.h.p. motors
	"Gniesenau" ..	20 to 21	Deschimag, Bremen ..	610 0	73 10	44 11¼	18,000	Twin-screw geared turbine ..	Four Wagner-Deschimag 711 lb., 470 deg. Cent. oil-fired boilers, and twin three-stage geared turbines, each 13,000 s.h.p.
Gdynia-America Line	"Pilsudski".. ..	18	Monfalcone, Trieste ..	493 3	70 6	37 6	14,500	Twin-screw Sulzer oil engines ..	Two nine-cyl., two-stroke, single-acting, C.R.A. Sulzer, 720 mm. bore, 1250 mm. stroke, 130 r.p.m., 12,500 s.h.p. total
British Cargo Ships									
Blue Star Line ..	"Australia Star"	16	Harland and Wolff, Ltd...	516 9	70 0	43 6	11,122	Twin-screw Harland-B. & W. oil engines	Two two-stroke, D.A., 620 mm. bore, 1400 mm. stroke, 95 r.p.m., 12,000 b.h.p. total
Shaw Savill Albion Co., Ltd.	"Wairangi" ..	15½ to 16	Harland and Wolff, Ltd...	515 0	70 0	43 4½	10,780	Twin-screw Harland-B. & W. engines	Two ten-cyl., four-stroke, S.A., pressure-charged oil engines, 740 mm. bore, 1500 mm. stroke, 112 r.p.m., 12,000 s.h.p. total
Commonwealth and Dominion Line	"Port Wyndham"	18	John Brown and Co., Ltd.	492 0	65 0	43 10	8,580	Twin-screw Brown-Doxford oil engines	Two four-cyl. opposed piston oil engines, 110 r.p.m., 700 mm. bore, 1650 mm. combined stroke, 9000 s.h.p.
	"Port Townsville"	18	Swan, Hunter and Wigham Richardson, Ltd.	495 0	65 0	43 10	8,600	Twin-screw Wallsend-Sulzer oil engines	Two eight-cyl. two-stroke S.A. engines, 720 mm. bore and 1250 mm. stroke, 9500 s.h.p. total
Union-Castle Line	"Roslin Castle"..	16	Harland and Wolff, Ltd..	420 0	61 0	36 9	7,016	Single-screw Harland-B. & W. oil engine	One 8-cyl. double-acting 2-st. engine, 620 mm. bore, 1400 mm. stroke, 93 r.p.m., 7000 s.h.p.
B. T. Sutherland and Co., Ltd.	"Sutherland" ..	10½ to 11	William Doxford and Son, Ltd.	419 6	54 3	28 8	5,000	Single-screw Doxford opposed-piston	One 1800 s.h.p. three-cyl., 115 r.p.m., bore 520 mm., combined stroke 2080 mm.
British Tankers									
Anglo-Saxon Petroleum Co., Ltd.	"Anclyus"	12 to 12½	Swan, Hunter and Wigham Richardson, Ltd.	460 0	59 0	34 0	8,000 gross 12,100 d.w.	Single-screw Hawthorn-Werkspoor oil engines	One 3750 s.h.p., four-stroke, S.A., supercharged engine, 650 mm. bore, 1400 mm. stroke, at 120 r.p.m.
Eagle Oil and Shipping Co., Ltd.	"San Arcadio" ..	12	Harland and Wolff, Ltd...	422 6	60 0	32 0	7,419 gross 12,000 d.w.	Single-screw Harland-B. & W. oil engines	One 3600 s.h.p., four-stroke, S.A., supercharged, 650 mm. bore, 1400 mm. stroke, 123 r.p.m.
Cross-channel Ships									
London, Midland & Scottish Rly. Co.	"Duke of York"..	21	Harland and Wolff, Ltd...	345 0	52 0	19 6	3,740	Twin-screw geared turbines ..	Four 225 lb. Babcock and Wilcox stoker-fired boilers, twin-screw geared turbines, 6000 s.h.p.
London & Southend Continental Shipping Co., Ltd.	"Queen of Channel"	18	William Denny and Bros., Ltd.	255 0	34 0	11 6	1,030	Twin-screw Sulzer oil engines ..	Two 1500 s.h.p., 320 r.p.m., two-stroke oil engines, 360 mm. bore, 600 mm. stroke
London and North-Eastern Rly. Co.	"Talisman" ..	17	A. and J. Inglis, Ltd. ..	215 6	27 6	9 6	544	Oil-electric paddle	Four 400 b.h.p. English-Electric generator sets, 1300 b.h.p., 50 r.p.m. motor

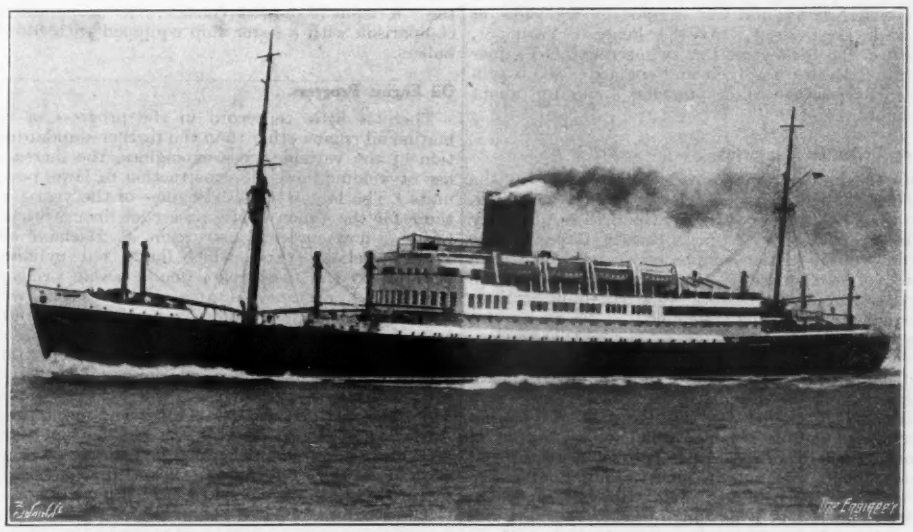
Barrow-in-Furness, completed naval and mercantile machinery of 92,000 and launched ships aggregating 27,088 tons. Two sets of machinery aggregating 6970 i.h.p. were delivered by the Central Marine Engine Works, West Hartlepool, which company also supplied a number of superheaters and steamship auxiliaries.

At the Turbinia Works of the Parsons Marine Steam Turbine Company, Ltd., 64,000 s.h.p. of geared turbines and 72,000 s.h.p. of mechanical gearing were manufactured, and in addition cut for its licensees 98,300 s.h.p. of gearing to be used in association with marine steam turbines. . At Birkenhead, Cammell Laird and Co., Ltd., launched four steamers and motor ships, totalling 31,244 gross tons and 27,900 i.h.p. During the past year 295 vessels of approximately 840,000 gross tons were dealt with by the repair departments at Birkenhead.

Liners Built Abroad.

Considerable interest attaches to the three 18,000-ton, 20-knot liners "Scharnhorst," "Potsdam," and "Gneisenau," completed in Germany for the Far East express service of the North German Lloyd Company. The "Scharnhorst," which entered the company's service during the summer—see accompanying engraving—is an electrically propelled ship and like her sister, the "Gneisenau," she was built at the A.G. Weser Yard of the Deutsche Schiff und Maschinenbau A.G., Bremen. Electrical propelling machinery was chosen and was constructed by the A.E.G. Company, of Berlin, and it is of interest to record that some of the special control gear was supplied by the British Thomson-Houston Company, Ltd., of Rugby. The turbo-generator sets, of which there are two, each have a normal output of 10,000 kW with 12,500 kW at maximum rating and run at 3120 r.p.m. Three-phase current is delivered at 3120 volts to the two 13,000 s.h.p. propelling motors, each of which drives a three-bladed propeller of about 18ft. diameter at 130 r.p.m. Special speed control gear is fitted to the turbines, which allows a speed control of 750 to 3360 r.p.m. to be carried out from the manœuvring platform. The steam plant is of interest, as it comprises four new design Wagner-Deschimag water-tube boilers. Each of these boilers has a heating surface of 6994 square feet with a 2238 square feet superheater and a 11,190 square feet air heater. There are two drums, the upper being a water gas welded 4ft. 5in. diameter drum and the lower a seamless rolled drum of about 3ft. 3in. diameter. Steam leaves the boilers at a pressure of 50 atmospheres, or about 711 lb. per square inch, with a temperature of 878 deg. Fah., and is supplied to the turbines at a pressure of 640 lb. and about 850 deg. Fah. The boilers are single-ended and the burners, of which there are two to each boiler, work on the Deschimag-Saacke system, on which the oil is fed into a special chamber in the burner and is atomised by the centrifugal effect of the primary air supply, the air pressure being maintained by separate electrically driven pumps. The secondary air is supplied by the fans working on the closed stokehold principle. The "Scharnhorst" has made several trips to the Far East, and we understand that her Maierform bow and lines have enabled her to keep good speeds even with heavy monsoon weather.

The second ship, the "Potsdam," was built by Blohm and Voss, of Hamburg, and although she is of the same dimensions her bow is of the firm's special bulbous type. The propelling machinery was entrusted to Siemens-Schuckert, of Berlin, and the boilers are of the Siemens-Benson type, constructed under licence by Blohm and Voss. The two turbo-alternator sets each have a normal output of 10,000 kW with 10 per cent. overload capacity, and three-phase current at 6000 volts is supplied to the two propelling motors, each of which has an output of 13,000 s.h.p. at 150 r.p.m. The turbine governors are of the Jahns-Thoma type and give wide speed regulation from the control board. There are four Benson boilers, each fired by four Blohm and Voss oil burners. The radiant heating surface of each boiler is 90 square metres, or about 968 square feet, and the superheater surface about 250 square metres, or 2790 square feet. There is a total heating surface of 590 square metres, or 6348 square feet, of which the radiant heat and superheating surfaces above mentioned form part. In the high-temperature zone of the boiler, where the

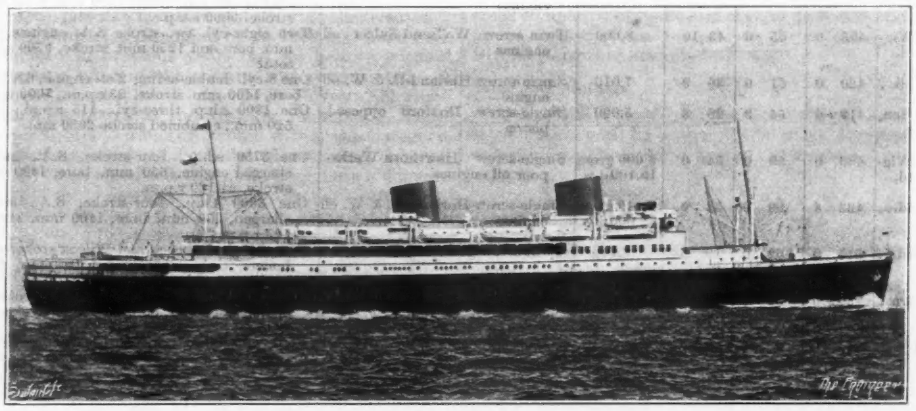


THE NORTH GERMAN-LLOYD LINER "SCHARNHORST"

tubes are in contact with the furnace gases, the maximum temperature does not exceed about 1290 deg. Fah. Steam is generated at 90 atmospheres, or 1280 lb. pressure, with a superheat temperature of 896 deg. Fah., and is supplied to the turbines at a gauge pressure of about 1140 lb. per square inch. The control of the boiler is based on the temperature of the superheated steam and is kept to the desired temperature within ±10 deg., the pressure of the oil fuel being varied by the control mechanism between 570 lb. and 106 lb., while a hand control is also provided. The steam control is worked from a control board arranged in the boiler room. We understand that the boilers have worked well during the recent voyages of the ship.

The third ship, the "Gneisenau," is generally similar to the "Scharnhorst," with a Maierform hull, and was built and engined by the Deschimag at Bremen. She is propelled by geared turbines, a twin-screw arrangement of three-stage turbines being adopted. The total output of each unit is 13,000 s.h.p. and the h.p. and i.p. turbines run at 7300 r.p.m. and the l.p. turbine at 2800 r.p.m. The l.p. pinion gears with the main wheel and the h.p. and i.p. pinions transmit their power to an intermediate geared countershaft. The propeller speed is about 130 r.p.m. Like the "Scharnhorst," the "Gneisenau" has four high-pressure Wagner-Deschimag water-tube boilers, which generate steam at 711 lb. pressure and at 878 deg. Fah. The "Gneisenau" completed successful trials shortly before the end of the year and she entered the company's service on January 3rd, sailing from Bremerhaven to the Far East.

Among other interesting liners completed during 1935 was the "Pilsudski"—see accompanying engraving—which is the first of two motor ships



GDYNIA-AMERICA MOTOR LINER "PILSUDSKI"

built by the Cantieri Riuniti dell' Adriatico, Monfalcone, and engined at the company's San Andrea Works, Trieste, for the Polish Transatlantic Shipping Company, of Gdynia. Another important motor liner was the "President Doumer," an 11,898 gross ton liner for the East African service of the Société des Services Contractuel des Messageries Maritimes. She was built by the Société Provençale de Construction Navales and was engined by Schneider et Cie., of Le Creusot. At the Penhoet Yard, St. Nazaire, the 9764 gross ton twin-screw C.G.T. liner "Ville d'Alger" was built and engined. She is propelled by geared turbines and has a speed of about 21 knots.

Some Boiler Developments.

Further progress was made during 1935 in the application of the pressure circulation type of boiler, and the Velox boiler ordered by the British Admiralty from Richardson Westgarth-Brown Boveri, Ltd., is now approaching completion at the Scotstoun Works of Yarrow and Co., Ltd., at which the pressure parts were built. The rotating parts, built at West Hartlepool, are being assembled at Scotstoun for steaming tests in a few months' time. On the Continent several naval-type Velox units are under test, and on the mercantile side it is announced that a Velox boiler will be fitted into the French ship "Athos II," owned by the Cie. des Messageries Maritimes. The new boiler will have an output of about 77,000 lb. of steam per hour at a pressure of about 700 lb. per square inch, and a final steam temperature of 840 deg. Fah. It will replace a Scotch boiler, and a new high-pressure turbine will be added. A Loeffler boiler, which is dealt with in this country by Mitchell Engineering Ltd., of London, is to be installed on the Beardmore-built Italian liner "Conte Rosso," in which one of the Scotch boilers is to be replaced by a 40,000 lb. per hour Loeffler boiler generating steam at 1850 lb. pressure with a high degree of superheat. New high-pressure turbines are to be installed.

The Sulzer mono-tube boiler has been under test in Switzerland for some time, and it has already been described in THE ENGINEER on various occasions. A boiler of this type is to be installed in Holland in the Rotterdam Lloyd liner "Kertosona," and the plant is now being assembled for preliminary land tests.

In England and Scotland further progress in boiler engineering has to be recorded, and during the year many interesting steam-raising installations were completed by Babcock and Wilcox, Ltd., of London and Renfrew. In addition to the two liners "Orion" and "Strathmore," referred to in our last article, 180 lb. pressure Babcock boilers were fitted in the Anglo-Saxon Petroleum Company's steam tankers "Rosa" and "Rita," which will be used in West Indian service. The L.M.S. passenger and cattle boat "Slieve League," for the Irish Channel service, was equipped with 225 lb. pressure Babcock boilers arranged for hand firing with turbine furnace fronts. Another important steamer was the "Duke of York," particulars of which are given in the accompanying table, which is equipped with 225 lb. stoker-fired boilers with self-trimming bunkers. So successful was the steaming of this ship that the sister ships, the "Duke of Rothesay" and the "Duke of Argyll," were equipped with mechanical stokers on the two forward boilers.

At Scotstoun, Yarrow and Co., Ltd., completed several sets of boilers for naval vessels, and towards the end of the year it was announced that boilers built under Yarrow licence would be installed in the new Holland America liner, a vessel of 28,000 tons. These boilers will be constructed by the Royal de Schelde Company, of Flushing. The Johnson boilers installed in the Royal Mail liners "Asturias" and "Alcantara" gave satisfactory results during the year as regards high efficiency and increased output, and enabled good time-keeping on all voyages to be maintained. The Howden gas-washing installations fitted to these ships were very effective in preventing particles falling on the decks. At the works of the Wallsend Slipway and Engineering Company, Ltd., a Johnson naval-type boiler was built for the destroyer "Hyperion," now under construction at Swan, Hunter and Wigham Richardson's yard.

Two installations of Howden Johnson boilers were completed during the year for the Booth liner "Crispin" and the Denny-built steamer "Anselm," while a further installation is to be built in Japan for Japanese owners. In practically a year's service the "Crispin" showed considerable economies in comparison with a sister ship equipped with Scotch boilers.

Oil Engine Progress.

There is little to record in the progress of the marine oil engine other than the further standardisation of the various types of engines, the increased use of welding, and the construction of large power units. The largest British engines of the year were those for the Union Castle passenger liner "Stirling Castle," now under construction at Harland and Wolff's Belfast Yard, which have ten cylinders working on the two-stroke, double-acting principle with airless injection and a tuned air scavenge, with waste-heat recovery. The cylinder bore is 660 mm., and the designed output 12,000 s.h.p. Abroad, the Fiat Company built two 13,000 s.h.p., double-acting, two-stroke engines, which were installed in the "Vulcania," and which have a cylinder bore of 740 mm. At Trieste the Cantieri Riuniti dell' Adriatico built two ten-cylinder 14,000 s.h.p. Sulzer 760 mm. bore, double-acting engines for the re-engining of the "Saturnia." One of these engines on test in December developed 20,820 b.h.p. at 152 r.p.m.

The Doxford opposed-piston engine was installed in many ships, and both in the three-cylinder standard 1800 b.h.p. design and the larger 3600 b.h.p., five-cylinder engines, built by Barclay Curle and Co., Ltd., for the passenger and troopship "Dilwara," and fully described in our issue of November 1st. Carefully confirmed fuel tests on B. and W. Doxford and Sulzer engines showed during the year figures of 0·335 lb. to 0·36 lb. per b.h.p.-hour, which may be taken as reliable figures for engines operating under service conditions. There was a further application of pressure charging and improvements were made in exhaust gas recovery plants. The makers of smaller propelling and auxiliary engines had a busy year, and many installations were completed by W. H. Allen, Sons and Co., Ltd., of Bedford; Crossley Brothers, Ltd., of London and Manchester; Mirrlees, Bickerton and Day, Ltd., of Hazel-Grove, Stockport; the National Gas and Oil Engine Company, Ltd., of Ashton-under-Lyme, and the Brush Electrical Engineering Company, Ltd., of Loughborough.

A New Switchgear Testing Plant.

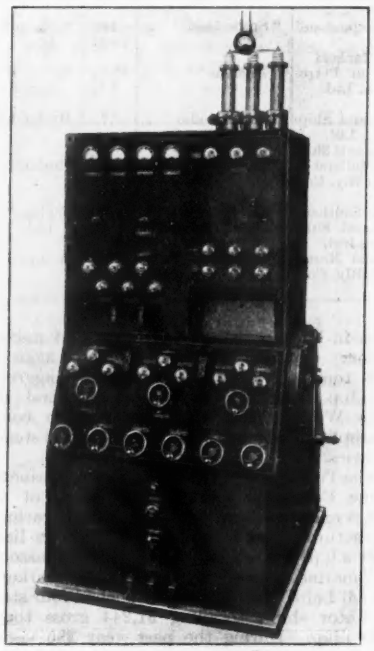
THE following preliminary account of the switchgear-testing plant of Associated Electrical Industries, Ltd., has been sent to us by the Switchgear Testing Company, Ltd., Manchester.

The development of the modern super power station and the advent of the grid system have greatly increased the responsibilities of switchgear designers. Switchgear failures in recent years have caused fires, costly damage to plant, and prolonged interruptions of supply.

The safety of any present-day supply system can be said to depend upon the ability of its circuit breakers to deal successfully with any fault conditions that may arise. In these circumstances the question of switchgear short circuit ratings has assumed a greatly increased significance, and it is now more than ever essential for switchgear manufacturers to do everything possible to ensure the dependability of the short circuit ratings assigned to their products.

The standard practice of the constituent firms of Associated Electrical Industries, Ltd., has been to carry out extensive routine short circuit tests with the aid of available generators of their own manufacture. They have also had ready access to short-circuit testing plants, both on the Continent and in the United States. Nevertheless, to meet increasing demands for more and larger tests and to provide for technical and engineering developments in this country, their existing facilities have been augmented by the erection of an entirely new and complete testing plant and by the creation of a new company, the Switchgear Testing Company, Ltd.

This company's plant, situated at Mosley-road, Trafford Park, Manchester, is jointly owned by the British



CATHODE RAY OSCILLOGRAPH

Thomson-Houston Company, Ltd., Ferguson Pailin, Ltd., and the Metropolitan-Vickers Electrical Company, Ltd., and has been designed specifically for the short-circuit testing of all types and sizes of switchgear. Circuit conditions of practically any degree of severity can be reproduced. The apparatus, which is provided for taking permanent records and measurements of circuit breaker performance under these conditions, is probably the most comprehensive yet available. The complete plant was designed by a committee drawn from the three companies concerned, and the whole of the testing apparatus, including the oscillographic equipment, was made in the factories and research departments of the three companies.

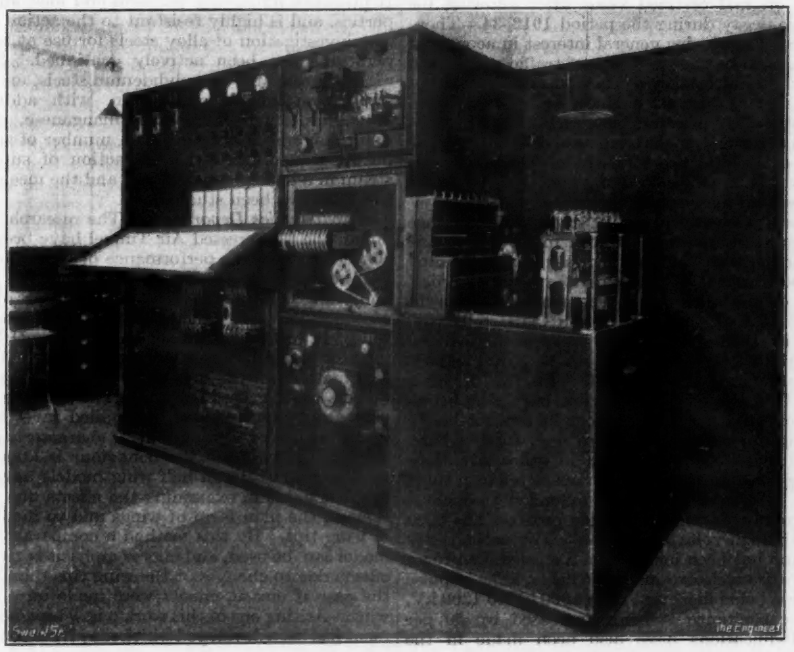
The various pieces of apparatus used for the production and control of a short circuit test all have points of technical interest, but to the switchgear designer the main value of the whole plant is centred in the oscillographic recording equipment. The use of this apparatus gives a complete and accurate record of the behaviour of a circuit breaker for the period during which short circuit conditions exist. A circuit breaker may successfully clear a certain short circuit and exhibit no external signs of distress, yet the permanent evidence produced by the oscillograph may be sufficient to condemn the breaker.

The oscillographic equipment in the new plant comprises both electro-magnetic and cathode-ray instruments, shown in the engravings. The electro-magnetic oscillograph represents an advance on previous designs, as it enables no less than sixteen records to be taken simultaneously on one film, thus obviating the troubles involved in co-relating records taken on separate films.

The cathode ray oscillograph is provided for the purpose of recording the high-frequency transient restriking voltage which occurs at the instant of the interruption

of the arc. Recent research work has shown that the performance to be obtained from a circuit breaker is appreciably affected by the nature of this transient. A record of it is therefore of great value. The duration of the transient is a matter of micro-seconds, and the cathode ray oscillographic equipment is the only type that will successfully record it. The instrument makes three simultaneous records on a single moving film with a velocity during exposure of approximately 90 m.p.h.

A further record is obtained by the use of a cine camera which is automatically brought into action at the commencement of a test. The information collected each time a test is made thus comprises sixteen general records,



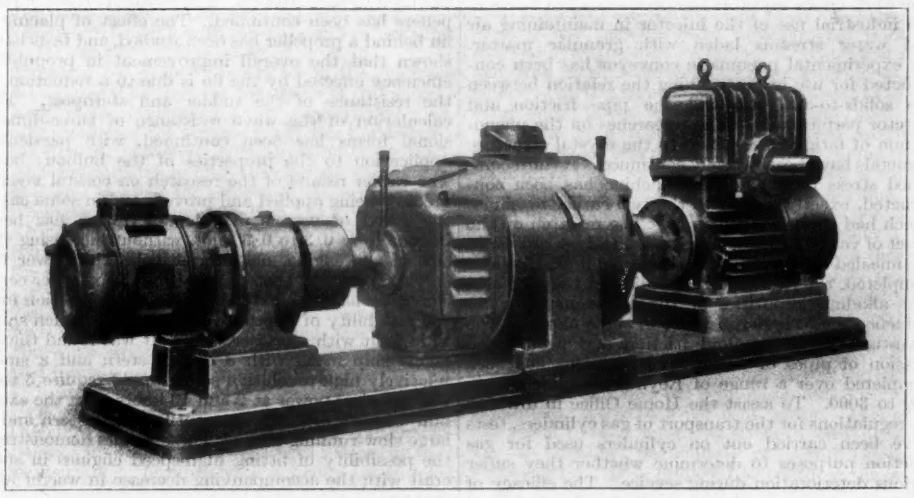
ELECTRO-MAGNETIC OSCILLOGRAPH

three records dealing with the high-frequency restriking voltage transient and one visual record.

The performance of an oil circuit breaker or air break switch cannot be forecast from a consideration of the mechanical and electrical characteristics of its various constituents. These are, of course, carefully considered and tested in the design and construction stages, but until the complete product has been exhaustively tested, in some cases to destruction, its rating cannot be assigned with confidence. The Switchgear Testing Company, devoted exclusively to the testing of complete switchgear units, is thus doing work which is of the greatest value to both the switchgear manufacturer and the switchgear user, as well as to the public in assisting to secure continuity of supply.

An Unusual Electric Machine Drive.

THE combination electric driving set which we illustrate herewith has just been produced by Crofts (Engineers), Ltd., of Thornbury, Bradford, for the purpose of driving a machine at a comparatively low speed which requires "inching" at fairly frequent intervals—that is to say, in preparing for operation the machine must be started and stopped very abruptly. The set is noteworthy on account of the fact that the individual parts have been taken from the makers' standard stock and only required assembling on a special bed-plate.



UNUSUAL ELECTRIC MACHINE DRIVE

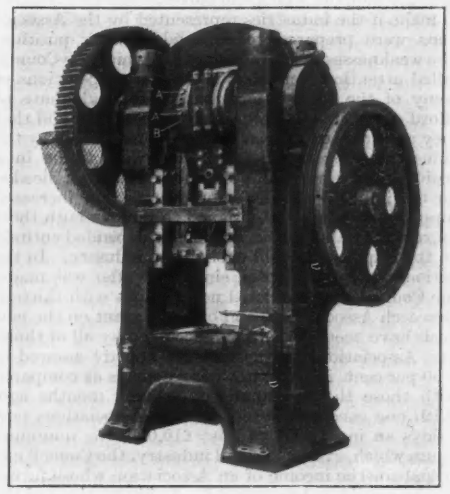
It comprises, reading from left to right in the illustration, the small motor for inching purposes, a speed-reduction gear-box, a ratchet coupling, the main driving motor, a flexible coupling, and a fan-cooled worm-reduction gear. During preparatory work, where the machine is required to drive at inching speeds, the geared motor is switched on, and the output speed is reduced to approximately 6 r.p.m., the first reduction at the output shaft of the geared motor being 1500/138 r.p.m.

When the machine is ready for production, the main motor is switched on, which on acceleration operates the automatic ratchet coupling, thus disconnecting the geared motor. An electrical relay automatically cuts off the current to the geared motor at this stage. The main motor is of the variable-speed type, and, with the help of the worm-reduction gear, drives the machine at any speed between 20 and 61·5 r.p.m. When the main motor is switched off and comes to rest, the pawls of the ratchet coupling automatically reset themselves for the next cycle of operations.

A 300-Ton Variable Stroke Press.

WE illustrate herewith a new form of heavy crank press with a variable stroke, which has recently been brought out by Hordern, Mason and Edwards, Ltd., of Birmingham, for all kinds of operations in the way of blanking, piercing, drawing, and forming in heavy gauge material. It is capable of exerting a pressure of 300 tons at the bottom of the stroke. The stresses in the frame produced by the pressure are taken, it will be seen, by long tension rods, which are of heat-treated nickel-chrome steel.

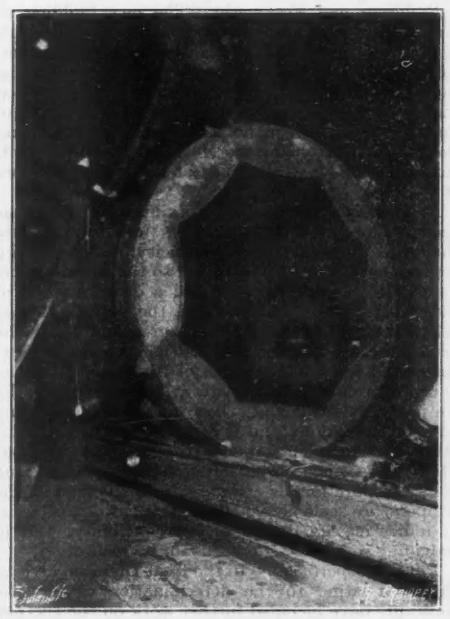
The variable stroke is obtained by a double excentric operated in a new manner. The double excentric is not, of course, novel, and is used in the company's smaller presses, but in such cases a simple serrated claw ring is used to lock the two parts of the excentric together, and is operated by hand. The new press, however, is too heavy to be handled in this manner, and a new system has been evolved. The variation in stroke is effected through the main gearing by turning the back shaft, thereby rendering the operation light and easy of adjustment. Two pins, marked A, in the claw ring B are first unscrewed and then a special spanner with a mandrel end is inserted into the connecting-rod and bush, locking them together. The claw ring B is then drawn to the left by a double excentric, which is permanently fitted in the crank shaft. The crank shaft is then turned from the fly-wheel through the gearing of the press and moves relatively to the connecting-rod and its excentric bush. Half a revolution of the crank shaft provides variations in stroke from 1in. to 6in., giving six variations of stroke in all. The claw ring is then re-engaged and the mandrel removed from the connecting-rod. The press is therefore well adapted to drawing operations involving strokes up to 6in., and can be quickly adapted to short strokes for blanking or piercing purposes. The slide of the press runs on four prismatic guides, and is balanced by counterweights attached by chains to the slide and working over small sprocket wheels, as in machine tool practice. The drive is transmitted through a positive type clutch, the machine making one revolution for each depression of the operating lever. Steel gearing is employed throughout, the high-speed shaft running in ring-oiled bearings bushed with phosphor bronze. The press is equipped for line shaft or electric motor drive, and can be supplied with air or oil-operated die cushions. An alternative model is also made with an outside type clutch and double reduction gearing, and both types can be supplied with variable stroke up to 6in. or any fixed stroke up to 8in.



300-TON VARIABLE STROKE PRESS

A Large Ingot Mould.

IT is claimed that the record for the largest steel ingot ever made in this country is held by the English Steel Corporation, Ltd., Sheffield, the ingot weighing 175 tons. This record is now to be broken, as the English Steel Corporation is being called upon to make forgings which will require ingots well over 200 tons in weight. What is said to be the largest mould ever made in the world is required for these ingots and necessitated the use of over 165 to 170 tons of molten metal. It has been made by the Brightside Foundry and Engineering Company at its Brightside Works and was delivered by motor lorry to the Vickers' works of the English Steel Corporation, Ltd. We illustrate the mould on the lorry.



LARGE INGOT MOULD

FIXED stopping places for omnibuses, now in only occasional use, are to be gradually established in the central area of London and on certain main routes outside that area. There will be approximately six stopping places to the mile; some will be compulsory and the remainder "By request."

Scientific and Industrial Research.

THE report of the Department of Scientific and Industrial Research for the year 1934–35—published by H.M. Stationery Office, price 3s. net—was issued on December 28th. In its introductory remarks the Advisory Council reports an encouraging development in the Research Association movement. A year ago the Council described the offer of increased financial support which the Government had decided to make if the industries represented by the Associations were prepared to consolidate their position. The weaknesses in the movement to which the Council called attention were that the scale of operations of many of the Associations was quite inadequate to afford any stable basis for effective working, and that they required to be given a more secure footing by the industries they benefited if they were to be in a position to recruit and maintain the staff needed for the important tasks before them. The increased support promised was designed to remove both these sources of weakness, but its efficacy depended entirely on the response it could evoke from industry. In the period which has elapsed since that offer was made, the Council has completed negotiations with thirteen Research Associations, and offers of grant on the new basis have been made to and accepted by all of them. The Associations in question are already assured of a 30 per cent. increase in their resources as compared with those they commanded eighteen months ago. With one exception, each of these Associations now enjoys an income of at least £10,000, the minimum figure which, even in a small industry, the Council can accept for the income of an Association whose future can be considered as assured. As illustrations of the response which various industries have made, it is recorded that the total income of the Iron and Steel Industrial Research Council is estimated at £31,000 in the current period, as compared with £16,000 two years ago, while the income of the Electrical and Allied Industries Research Association has increased in two years from £44,000 to £64,000. The resources of the Cotton Industry Research Association have already increased in one year from £58,000 to £75,000; those of the Paint Research Association from £9000 to £14,000; and of the Flour Millers' Research Association from £7600 to £13,000. These increases are due more to industrial support than to Government grants.

Following the Advisory Council's introductory remarks, there is given the customary review of the work carried out under the various research organisations of the Department during the year. From this section of the Report we abstract the following notes:

National Physical Laboratory.

Buildings and Equipment.—The new building to provide more adequate accommodation for the work of the Photometry Division is now approaching completion, and the installation of equipment will be started shortly. The construction of the high-speed wind tunnel designed to work from the exhaust of the compressed air tunnel has been completed, and the balances are being installed. A speed of 975ft. per second has been obtained at an applied pressure of 60 lb. per square inch.

Fundamental Standards.—Continued progress has been made with investigations on fundamental standards in the Physics, Electricity, and Metrology departments. The work related to the International Temperature Scale has included a determination of the freezing point of platinum, the value obtained (1773·3 deg. Cent.) being in agreement with the results recorded at the national laboratories of Germany and the United States of America within the limits of accuracy which are at present attainable. An investigation has also been made of the freezing point of palladium, and it is proposed to determine other freezing points up to that of iridium (about 2450 deg. Cent.). The determinations of freezing points of pure metals coming within the part of the temperature scale above 1063 deg. Cent. are of value in indicating its degree of reproducibility, and in providing secondary standards for its realisation.

Physics Department.—In the Heat Division, investigations relating to the determination of physical constants have included further work on the thermal and electrical conductivity of metals and alloys at high temperatures, the thermal conductivity of refractories at high temperatures, and the ratio of specific heats of gases at high temperatures. The ratio of the specific heats of carbon-monoxide has been determined up to 1800 deg. Cent. by means of the velocity of sound method, the values found being in good agreement with those derived from spectroscopic data. In the Radiology Division work on X-ray spectrometry has included a further study of the structural changes produced by the cold working of metals. Cold work gives rise, in general, to a broadening of the lines in the X-ray diffraction pattern, and this broadening has been shown experimentally to be a measure of the amount of strain in the crystal lattice. The British National Radium Standard, which had been in the custody of the Laboratory for over twenty years, was replaced during the past year by a new standard consisting of 20·50 mg. of exceptionally pure anhydrous radium chloride, equivalent to 15·60 mg. of radium element. The comparison of the old and the new standards has shown that the value of the radium content of the old standard, based on that of the new, agrees to within about 0·3 per cent. with the figure derived from the original certified value after allowing for radioactive decay during the period 1912–34. There is evidence of increasing general interest in acoustical questions, such as the exclusion of traffic noise from buildings, the mitigation of the nuisance caused by noisy machinery, aircraft engines, &c. The services of the Laboratory in connection with noise measurement and noise abatement have been called for by the Ministry of Health, the Ministry of Transport, the Post Office, H.M. Office of Works, one of the railway companies, and many public bodies.

Electricity Department.—Six standard resistance coils of pure platinum have been made during the year, their construction being such as may be expected to give permanence of the highest attainable order. Detailed comparisons have been made in order to investigate the permanence of the Clark cells constructed in 1933, from which it appears doubtful whether the Clark cell is likely to be as permanent as the standard Weston cell. In the Electrotechnics Division an investigation has been begun into the effective resistance of conductors for heavy alternating currents, such as are used for bus-bars, electric furnace conductors and in other situations where large currents have to be transmitted over short distances. The work is being extended to include tubular conductors. Considerable progress has been made with high-voltage research. The cathode-ray oscillograph has been installed in a steel-walled room to screen it from electro-magnetic fields. The impulse generator is being increased from 1000 kV to 1200 kV, and the capacitance is being increased by 50 per cent. Modifications have also been made in the design of the experimental high-voltage vacuum condenser. A number of important investigations on surge phenomena are in hand. The testing of integrating meters for the Electricity Commissioners in connection with their approval of meter types continues to form an important part of the test work of the Division; an outstanding feature of the past year's work has been the number of prepayment meters submitted, due largely to the introduction of prepayment mechanisms adapted to work on the "two-part" tariff.

Metrology Department.—The reconstruction of the standard leading screw lathe has been completed. The traverse of the lathe has been extended from 3ft. to 5ft., and whereas formerly the use of the lathe was restricted to the correction of screws having only ¼in. pitch, it is now possible, by the introduction of change gears, to deal with screws having any of the ordinary English or metric right-hand pitches. It is hoped that it will shortly be possible to correct screws up to 10ft. in length by working from each end of the screw. Work has been continued on the stability of gauges, and on the comparative resistance to wear of gauge steels and other materials.

Engineering Department.—A new piezo-electric gauge for recording impact stresses on a time base has been made, and is giving satisfactory results. The work on air injectors has been extended to cover the industrial use of the injector in maintaining air and water streams laden with granular matter. An experimental pneumatic conveyor has been constructed for use in determining the relation between the solids-to-air ratio and the pipe friction and injector performance. The researches on the phenomenon of fatigue in relation to the crystal structure of metals have been actively continued. A third combined stress fatigue testing machine has been constructed, exactly similar to the two earlier machines which had proved satisfactory. The research on the effect of various atmospheres on the fatigue resistance of annealed copper and annealed 70/30 brass has been completed, the results having indicated that the acid and alkaline impurities of the atmosphere do not influence the fatigue resistance of these metals. The investigation of the fluid friction and heat transmission of pipes of various cross-sections has been completed over a range of Reynolds numbers from 100 to 3000. To assist the Home Office in drawing up regulations for the transport of gas cylinders, tests have been carried out on cylinders used for gas traction purposes to determine whether they suffer serious deterioration during service. The efficacy of the safety devices used on gas cylinders has also been the subject of investigation. Considerable progress has been made in the experimental study of the corrosion of metals when subjected to relative movement whilst in contact under pressure; and tests on the protective value of various coatings, and on the effect of the mean stress of the cycle on the resistance of metals to corrosion fatigue have been continued.

Metallurgy Department.—The production of iron of high purity by the methods developed in the Laboratory has been continued. The high-purity iron is remarkably soft and ductile, and can be well rolled into rod and foil. The purified iron thus produced has been used in the investigation of the iron-carbon system, and in this connection it has been necessary to develop special refractories for use in melting the alloys. Although iron itself has no action on pure alumina vessels, reduction occurs in the presence of carbon and some aluminium passes into the metal. A method has therefore been devised for lining the crucibles with thoria, and attempts are also being made to avoid the contamination of glazed alumina thermo-couple tubes. An iron-rhodium alloy containing 52 per cent. of rhodium has been made from iron and rhodium of high purity. It possesses interesting physical and mechanical properties, and is highly resistant to the action of acids. The investigation of alloy steels for use at high temperatures has been actively continued. Series of carbon steels and of molybdenum steels, and several steels containing molybdenum, with additions of vanadium, tungsten, copper, manganese, and titanium, have been examined. A number of specimens have been subjected to the action of superheated steam in a high-pressure vessel and the mechanism of corrosion has been studied.

Aerodynamics Department.—The researches carried out in the Compressed Air Tunnel have been mainly concerned with the performance of well-known aerofoil sections over a wide range of Reynolds number, and, using some of these sections, with tests of a model of the "Parasol" monoplane for comparison with full-scale results. In addition, the tunnel has been used for tests on complete models and parts to provide information during the development stage of new designs of aircraft. In connection with the research on stability and control, a detailed investigation is being made of the stability characteristics of a machine whose full-scale behaviour is known to be very good. Tests on half-wing models have proved of great value in examining the effects due to variations in the plan form of wings and to modifications in wing tips. By this method a comparatively large model can be used, and more emphasis is given to the effects due to changes at the wing tips than would be the case if measurements were made on a complete wing. Arising out of this work a new biplane arrangement has been developed which may have considerable advantages, especially as regards controllability at low speeds. Problems relating to the landing of aircraft are becoming of great importance, since the efficiency of modern high-speed machines is such that, having very low drag, they glide in to land at a fine angle and take a long time to lose their speed and come to rest. It has been made clear from a theoretical investigation that a device is required which, preparatory to landing, increases maximum lift moderately and the drag/lift ratio considerably, without involving a large increase of ground angle. A number of model tests of flaps and other "spoiling" devices for this purpose have been carried out in the compressed air tunnel.

William Froude Laboratory.—The increased demand for test and research work for commercial firms has been maintained. In many instances these tests have resulted in considerable economy in ship performance with the retention of all the features which stand for seaworthiness. Of the sixty designs submitted during 1934, improvements ranging from 2½ per cent. to upwards of 15 per cent. have been effected in fifty-four cases as a result of modifications made at the Laboratory. The improvement is stated in terms of the power required for propulsion at the service speed for the ship. The influence of waves on the resistance, propulsion, and pitching of ships has been further studied. The research on screw propellers has been continued. The effect of placing a fin behind a propeller has been studied, and tests have shown that the overall improvement in propulsive efficiency effected by the fin is due to a reduction in the resistance of the rudder and sternpost. The calculation of the wave resistance of three-dimensional forms has been continued, with particular application to the properties of the bulbous bow. The earlier results of the research on coastal vessels are now being applied and proved, and in some cases the speed of vessels of this description has been increased by 0·3 to 0·5 knot, without increasing the size of the engine, or, alternatively, the power for service speed has been reduced by 15 to 20 per cent. The work has been extended by an investigation into the possibility of improved performance if such ships were built with a cruiser stern. It was found that a 200ft. ship fitted with a cruiser stern and a small relatively high-revolution screw would require 5 to 7 per cent. less power at 9 and 10 knots than the same hull with an ordinary mercantile raised stern and a large slow-running screw. These results demonstrate the possibility of fitting high-speed engines in such craft with the accompanying decrease in weight and first cost.

Fuel Research.

An account of the work of the Fuel Research Board for the year ended March 31st, 1935, will be found in our issue of December 6th.

Building Research.

The investigation into the behaviour of reinforced concrete piles, which was initiated as a direct result of troubles experienced while driving piles through a hard stratum to a set in firm ground below, has

been continued with the collaboration of the Federation of Civil Engineering Contractors. The main problem of the investigation was to devise methods of estimating the amount of driving that a pile would stand without damage. This involved, first, an examination of the nature and magnitude of the stresses induced in piles by impact blows, and the determination of the extent to which these stresses were modified by changes in driving conditions, and, secondly, of the effect upon impact resistance of the different factors controlling the design and manufacture of the pile itself. One important feature of the work has been the development of an instrument for attachment to the upper surface of the hammer, which, in combination with a special indicator circuit, makes it possible to estimate the maximum stresses at the head of a pile during driving. The investigations on reinforced concrete in co-operation with the Reinforced Concrete Association have been extended to include such studies as the effect of clay content on the formation of shrinkage cracks, the effect of the sand content on the strength and workability of concrete, and the redistribution of moments that occurs in reinforced concrete both at working stresses and near failure. It is particularly desirable that cements used for mass concrete structures should have a low heat of hydration, and that it should be possible to predict from the results of laboratory tests of the cement the temperatures that may be attained in a mass of concrete made from it. Through the courtesy of Sir Alexander Gibb and Partners, and Messrs. Meik and Halcrow, it has been possible to obtain records of the temperatures attained in the concrete of three large dams recently completed, and to compare these records with the time-temperature curves given by laboratory tests of the cements used for these works. Although further tests are needed before an exact correlation can be established, approximate relations can already be given which may be used for the tentative prediction of the temperatures that will be reached in a large mass of concrete made with a given cement.

A co-operative research has been arranged with the Iron and Steel Industrial Research Council of the British Iron and Steel Federation and a firm of building contractors to study the properties and methods for testing slag aggregates for concrete. Particular attention is being paid initially to foamed slag, which is being widely used in Germany, but the study of air-cooled slag is also included in the programme and preliminary work on this is in progress.

Steel Structures Research.

The financial arrangements for the work of the Steel Structures Research Committee made between the Department and the British Steelwork Association terminated in September, 1934, but the Department continued to provide facilities to enable the Committee to draw up conclusions and consider the practical applications of the results obtained. The Committee is now engaged on a Final Report, which it is hoped will be published shortly. The analysis has been completed of the mass of observations taken on the behaviour of the steel framework under load of a hotel building, an office building, and a block of residential flats. Professor Batho has completed his investigations at Birmingham University on riveted and bolted joints. Professor Baker has contributed papers on wind stresses in building frames. The limited time and funds at the disposal of the Committee have not permitted an investigation of wind stresses sufficiently extensive to warrant the preparation of general rules for the design of frames to withstand wind loads. Allowance for effects of wind will therefore be dealt with otherwise in the new draft rules for design.

Attention has been concentrated on the evolution of an improved method for the design of frameworks of multi-storey buildings. Draft rules are now practically completed for publication in the Committee's Final Report. Satisfactory progress has been made in the investigations into the use of electric arc (metal arc) welding for structural steelwork, which are being conducted on behalf of the Committee at the National Physical Laboratory with the collaboration of welding firms. It is hoped that the results of the statistical examination of the strength of welds will be available in time for inclusion in the Committee's Final Report. Fatigue tests on weld metal and welded joints are being completed, and the whole of the work envisaged on non-destructive tests for welded joints is nearly finished.

Road Research.

The investigations of the effects of the characteristics of the vehicle upon the impact forces applied to a road are in progress with a heavy six-wheeled lorry. In connection with the work on skidding, consideration has been given to the possibility of investigating the problem by means of models. The road-testing machine which was transferred from the National Physical Laboratory has been considerably modified. The construction of the 110ft. road-testing machine is well under way. The main feature of the machine is the employment of a commercial motor lorry chassis as the road-testing "tool." The loaded lorry is tethered to a centre post round which it travels on a track 110ft. in diameter and 10ft. wide. The machine is being placed in a building which provides a roof over the track in order to facilitate laying the test roads, irrespective of weather conditions. The construction of a sixteen-wheeled carriage for use in the measurement of surface irregularities is nearly completed.

Forest Products Research.

The four main railway companies and the Forestry Commission have co-operated with the Laboratory in an investigation which has for its objects the testing of the suitability for railway sleepers of certain species of timber grown in the British Isles, and the production of a treated sleeper which will have a life at least as long as those previously employed, while costing less; 4400 sleepers have been treated in various ways, and these will be laid in railway tracks at eight different sites, and a record of their behaviour will be made. Work on the nature of creosote extracted from old creosoted timber has been continued. A standard method of testing certain aspects of the natural fire resistance of various timbers, using relatively small specimens, has been evolved. Such small-scale experiments cannot compare in value with those made on complete structural units, but they are useful as a means of showing which species possess sufficient resistance to fire to justify the expense entailed in carrying out trials on a full scale.

Metallurgical Research.

Behaviour of Materials at High Temperatures.—The research on the behaviour of cast irons at high temperatures has been concluded. Data have been obtained concerning the creep and growth of five types of cast iron at temperatures up to 538 deg. Cent., corresponding with the range of temperature met with in steam plant. Both growth and creep of ordinary cast iron and nickel-chromium cast iron at 538 deg. Cent. have been found to be reduced considerably by giving a preliminary heat treatment at 650 deg. Cent. or even at 600 deg. Cent. Tests at 850 deg. Cent. have been carried out on heat-resisting irons of the high-silicon or austenitic types, whilst the rate of scaling of the whole range of irons in synthetic flue gas at 700 deg. Cent. has also been studied. The investigation shows that the use of cast iron in steam plant and elsewhere may well be extended, and it is anticipated that the results obtained will encourage the industries concerned to undertake further work along the lines indicated. The investigation of the influence of the initial condition of steels on their creep properties is proceeding, and preliminary creep tests have been carried out on a carbon steel and on a carbon-molybdenum steel obtained in various conditions from the manufacturers. In the hot-rolled condition the carbon steel is somewhat inferior in creep resistance to several similar steels previously tested, whilst after normalising it possesses very poor creep strength. The reasons for this and similar cases of abnormal behaviour are being sought, but a further carbon steel has been obtained which, if satisfactory, will be used in conjunction with the carbon-molybdenum steel for the main programme of tests. Research on the behaviour of metals under deformation at high temperatures has been continued. Study has been made by microscopical examination of the materials after creep and short-time tensile tests at high temperatures, test pieces being kept free from attack by air by stressing in vacuo in special testing units. The nature of the creep movement has been correlated with the structural changes observed both on the surface of polished test pieces and on internal sections.

Research on Light Alloys.—An investigation on the development of magnesium alloys of good mechanical properties is receiving prior attention. The programme also includes some constitutional work on magnesium-rich alloys containing cadmium and zinc, and work on the heat treatment and mechanical properties of certain ternary and complex alloys. Certain magnesium alloys containing cadmium and zinc have now been successfully rolled from extruded material, which was found to respond to rolling treatment much more readily than cast material of similar composition. By suitable mechanical working and heat treatment an alloy containing 8 per cent. cadmium and 8 per cent. aluminium (density 1·92) obtained mechanical properties approaching those of duralumin (density 2·8). It is proposed to modify the composition slightly with a view to improving the resistance to corrosion. An investigation has been made on the influence of various added elements on the mechanical properties of press-forged alloys. Some measure of success has been met in the case of an alloy containing 8 per cent. cadmium, 8 per cent. aluminium, and 2 to 3 per cent. silver. This alloy was found to have improved strength without much loss of ductility, particularly at slightly elevated temperatures. It is proposed to continue the work, giving special attention to the production of press forgings suitable for use at elevated temperatures, and for this work a modified press is under construction.

Alloy Steels.—The study of alloy steels, with particular reference to the properties induced by temper-hardening, has been commenced by an investigation of copper-chromium steels containing up to 4 per cent. copper, together with the determination of the influence of other alloy elements on the temper-hardening characteristics of low-carbon copper steels. Work on the metallography of the iron-tantalum alloys is approaching completion. The possible utility of tantalum in steels used for nitrogen hardening, or in steels in which the properties of the carbide of tantalum may be of value, is being examined.

Cracking of Boiler Plates.—A final report is being published upon the experiments at 300 deg. Cent. on mild steel strips subject to local concentration of stress at drilled holes and machined notches. The results show clearly that concentration of stress, localised cold work, and temperature are not sufficient in themselves to bring about failure. Prolonged stress and tensile tests upon specimens of boiler plates of the nature described in the previous report have been continued in the specially designed steel cylinder, but no widespread intercrystalline cracking of the kind found in failures in service has been produced in the specimens tested. Further work is being carried out under intensified conditions of test. The full-scale investigations into the behaviour of steel boiler plate and riveted joints under corrosion fatigue conditions, comparable to those which might occur in a boiler, have been continued upon the specially designed machine for the application of alternating bending stresses at slow speeds.

Water Pollution Research.

Commercial base-exchange materials in use for softening water may be divided into two main groups, synthetic products and treated minerals. Some of the synthetic products are manufactured in this country, but the minerals are imported, mainly from outside the Empire. Experiments have been continued at the Department's Chemical Research Laboratory on methods of treatment of British clays with the object of preparing materials suitable for water softening. From some of the clays materials have now been obtained which are not only equal in base-exchange value to imported treated clays in commercial use, but are more resistant to disintegration. Experiments at the Chemical Research Laboratory have led to the discovery that synthetic resins prepared from certain phenols and tannins possess marked base-exchange properties. Some of these resins are as effective as the best commercial water-softening materials in removing calcium and magnesium from hard water. Other resins prepared from aromatic bases, such as aniline, possess the property of removing anions or acidic radicals from solution. By passing water through granules of the two classes of resins in separate tubes arranged in series, the salts in solution can be removed. For example, by treating Teddington tap water first with a tannin resin and then with an aniline resin, the solids in solution were reduced from about 33 parts to about 1 part per 100,000. The same process carried out two or three times removes most of the salt from sea water.

Chemical Research.

Numerous samples of coal ash have been examined for the presence of germanium and large-scale extractions have been carried out on the more promising samples. In addition, a study has been made of certain flue dusts for the presence of gallium, with, in many instances, promising results. Some work has also been done on the chemistry of rhenium, and interesting results have been obtained by a study of ruthenium, a rare element of the platinum group.

Lubrication Research.

The comparative tests described last year with stainless steel and mild steel journals are in abeyance for the present, since no reason can be found for the failure of the particular stainless steel supplied to the Laboratory. Investigations are being begun to ascertain the effect of small quantities of water upon the seizing temperature of oil.

The work on the hardened steel bush and journal is nearly complete, and a series of observations on several oils at high speeds of oscillation is in hand. The study of extreme pressure lubricants has been added to the programme of the Lubrication Research Committee. For this purpose a Boerlage four-ball testing machine has been purchased. A rolling type of testing machine is under construction and experimental work on these machines will shortly be begun. An investigation is being undertaken in conjunction with the Fuel Research Station into the production of lubricating oil from coal. The samples of oil which have so far been prepared for testing are small, and the oils supplied have not, as yet, proved satisfactory under test. Experiments are in progress to determine how far the synthetic oils may be used to dilute good lubricating oils without adversely affecting their lubricating value.

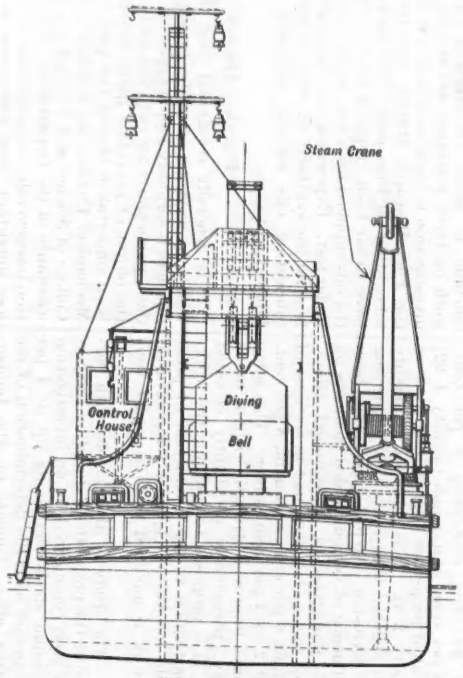
Furnace Design.

It is generally recognised that the engineer who wishes to work on scientific principles in designing furnaces is seriously handicapped by lack of adequate data, particularly for radiation and convection. With the object of providing more information, work has been undertaken during the past two years in the Mechanical Engineering Department of the Imperial College of Science and Technology, with the financial assistance of the Department. Until recently, radiation has generally been assumed to be relatively much less important than convection in the transfer of heat from the hot products of combustion in a furnace. Schack pointed out that this was not consistent with laboratory determinations of absorption spectra, and

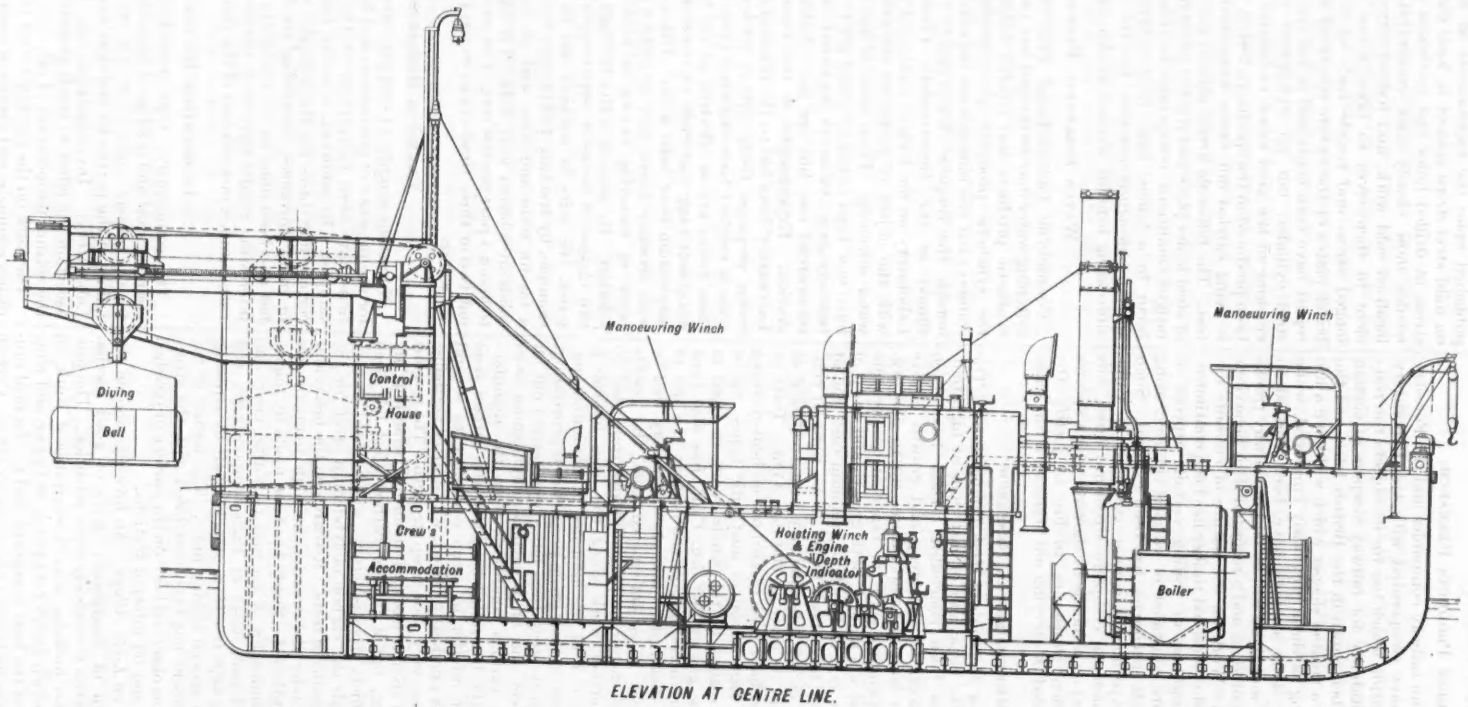
STEAM DIVING BELL BARGE

WM. SIMONS AND CO., LTD., RENFREW, BUILDERS

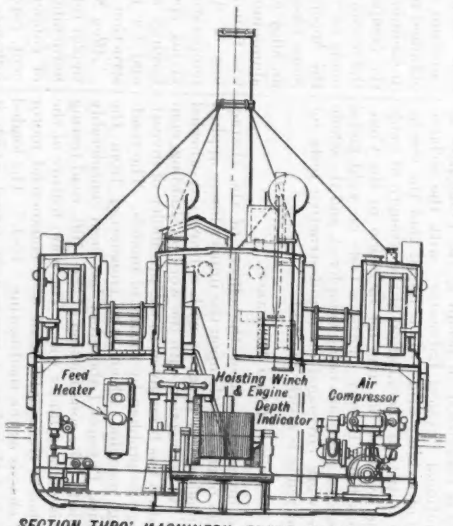
(For description see opposite page.)



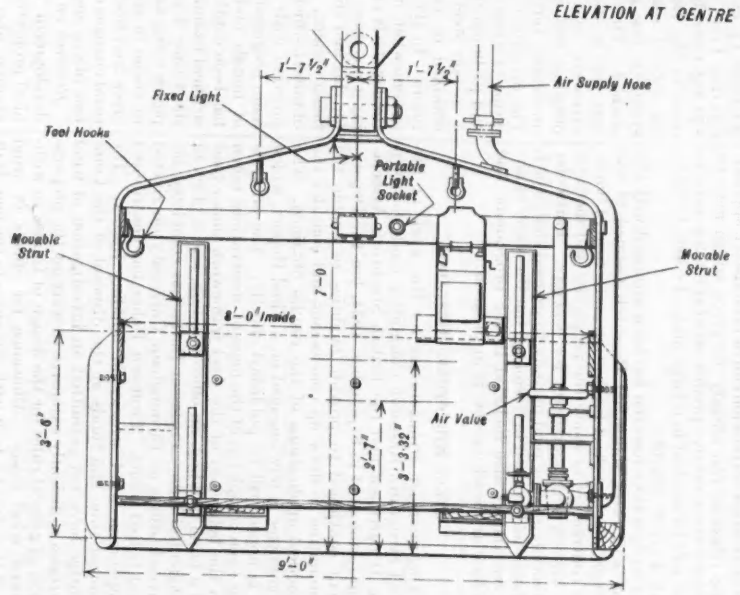
VIEW OF AFT END.

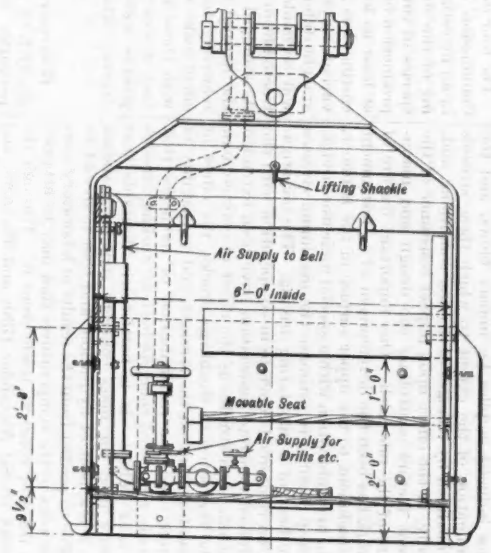


ELEVATION AT CENTRE LINE.



SECTION THRO' MACHINERY SPACE LOOKING FOR'D



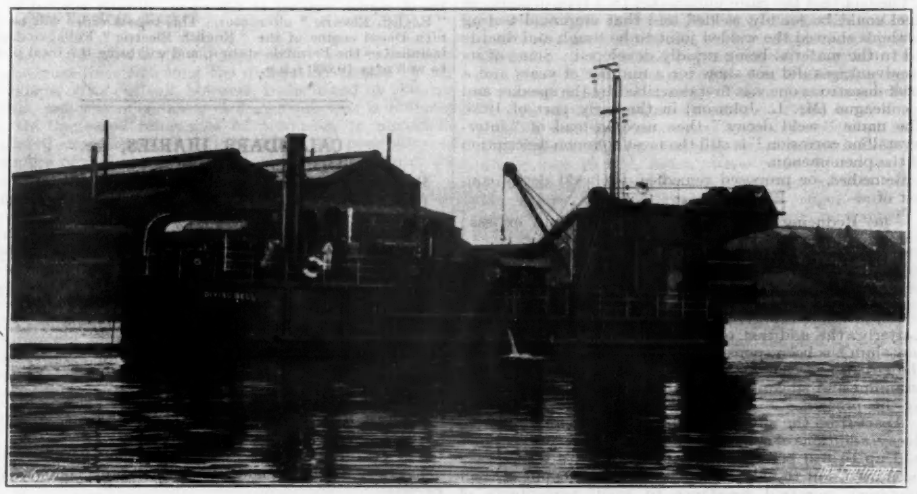


"THE ENGINEER"

he made numerical estimates of the radiation to be expected under various conditions from water vapour and carbon dioxide, the main products of combustion of all common fuels. The emission follows such complicated laws, however, that Schack's results are only approximate, and much of the work done at the College has been planned with the object of obtaining comparable experimental data. Measurements of the heat transmission from the products of combustion of town's gas burned in a small furnace with varying proportions of excess air, and flowing at velocities of about 2ft. per second through a 12in. diameter tube of special heat-resistant nickel-chromium steel, have been carried out over a temperature range from about 1000 deg. to 2000 deg. Fah. The first step was to develop an accurate method of measuring the gas temperatures. Platinum platinum-rhodium thermocouples in groups of three with wire diameters 0·02in., 0·01in., and 0·005in. respectively were finally used, their indications being extrapolated to zero diameter. Readings of both gas and internal tube wall temperatures were taken in four positions, at intervals of 2ft. along the experimental tube. The heat transmission coefficients so determined agree closely with Schack's figures, and are of the order of more than ten times the calculated convection. For higher velocities, since convection increases with the 0·8th power of the velocity, while radiation is independent of the velocity, this figure is reduced.

A Steam Diving Bell Barge.

IN the accompanying drawings and engraving we illustrate an interesting diving bell barge which has recently been completed by W. Simons and Co., Ltd., of Renfrew, for the Clyde Navigation Trustees, and is being used in connection with the work of dredging a deep channel for the safe passage of the 75,000-ton Cunard-White Star liner "Queen Mary" from John Brown's Clydebank yard, where she is being fitted out, to the "Tail of the Bank" at Greenock. The channel of the river Clyde from Glasgow to the sea is interspersed with large boulders, which may weigh from 5 to 15 tons, and with intrusive dykes in the rocky bed, for the removal of which a diving bell is essential. The new bell barge and



DIVING BELL BARGE FOR CLYDE NAVIGATION TRUSTEES

diving bell are of larger capacity than hitherto employed, and will replace a smaller equipment. The barge is designed to operate at a maximum depth of 60ft. in protected waters, a diving bell weighing 16 tons, and to manœuvre, hoist, and lower it at a speed of 15ft. per minute. In addition to these duties, the vessel will also be employed for the examination and repair of quay walls and dock sills and the removal of submerged materials.

THE DIVING BELL BARGE.

The hull of the barge, which was constructed to the requirements of the British Corporation Register of Shipping and Aircraft Special Survey has a length of 81ft. 6in., a breadth moulded of 26ft., and a depth of 10ft. 3in., with a measurement of 180 gross tons. The mean draught in salt water with steam up, 15 tons of coal in the bunkers, 5 tons of water in the feed tank, and the diving bell on its inboard seat, is about 5ft. 9in. Siemens steel plating was used, and the hull is divided into eight transverse compartments by seven water-tight bulkheads, which are carried up to the main and forecastle decks. There are also two longitudinal bulkheads which form ballast tanks forward of the stokehold, and a tank for fresh water amidships. As our drawing on the opposite page indicates, there is a deck house over the hoisting engine and the boiler, while aft a control house is provided. Attention may be called to the design and construction of the framing for the support of the bell, which is designed to have a safety factor of 8 with the 16-ton diving bell suspended at its maximum outreach. The structure is strongly braced, and the two supporting legs are carried down and attached to the ship's floors. The arrangements enable the bell to be hoisted 2ft. clear of the main deck and travelled from the housed position to 6ft. 6in. from the chafing strake to the centre of the bell.

The auxiliary deck machinery comprises two steam mooring winches placed fore and aft, which were supplied by Thomas Reid and Sons, Ltd., of Paisley. There is also a Caldwell steam crane of the self-supporting type, which is fixed to a special seating provided at the end of the vessel. It is designed to lift direct from the barrel a load of 5 tons over the end of the vessel and to lift and slew a load of 3 tons at the same radius for the full travel. The height of the head of the jib is about 20ft. from the level of the deck.

The vessel carries the normal equipment of boats and signal lights, a signal mast carrying four-way lights being provided in addition to the usual side lanterns. The signal lamps are equipped with 40-watt lamps taking supply from the ship's lighting system, while 12-volt lamps are also fitted for use when the lighting set is not in operation, a battery then being employed.

THE MACHINERY INSTALLATION.

The machinery installation is of more than usual interest and embodies some new features in the design and equipment of a diving bell barge. The hoisting machinery consists of one twin-cylinder, 9in. by 12in., direct-acting, surface-condensing engine, with a designed output of 120 i.h.p., which drives through intermediate gearing the spur wheel on the barrel of the winch. In contra-distinction to the usual practice of lifting chains, the diving bell is carried on four wire ropes of 3¼in. diameter, which are made of four oval flattened strands and have an ultimate breaking stress of 36 tons. They are made in accordance with the specification of the Clyde Navigation Trustees, and were supplied by Wright's Ropes, Ltd. The length of rope on the barrel is about 68ft. The brakes are of the self-centring clamp type with Ferodo lining. Steam is supplied by a cylindrical multi-tubular marine type boiler, with a standard working pressure of 130 lb. per square inch, but the safety valves are loaded at a pressure of 120 lb. The furnace flues are of the withdrawable corrugated Deighton type, with Douglas furnace fronts and McConnell's air bridges. The auxiliary pumps comprise Weir air, circulating and feed pumps, with Dawson and Downie bilge and ballast pumps of the vertical duplex pattern. The electric lighting equipment comprises a steam engine driven dynamo set of Drysdale-Laurence Scott make, with a designed output of 3 kW at 110 volts, running at 500 r.p.m. For standby or harbour service a 12-volt nickel-iron battery, with 100 ampère-hour capacity, is provided. For supplying compressed air for drills, &c., a steam air compressor set of the twin-cylinder vertical type, with intercoolers, is provided. This compressor is designed to deliver 150 cubic feet of free air per minute at 115 lb. per square inch, when running at 410 r.p.m. and supplied with 100 lb. steam pressure, exhausting at 25in. vacuum. An automatic unloading and maximum speed device is fitted. A receiver of 7ft. in length and 3ft. diameter is utilised for air storage purposes. A filtering medium is incorporated in the receiver for removing any oil carried over by the air, which would be detrimental to the health of the men working in the diving bell.

THE DIVING BELL.

The diving bell was built in the Clyde Trustees' workshops at Renfrew to the requirements of Mr. A. C. Gardner, M. Inst. C.E., M.I. Mech. E., the civil engineer to the Trust. It is of rectangular form, as the drawing reproduced on the opposite page indicates, and is built up of 1in. steel plates electrically welded together. The vertical height from the lower side of the shackle to the under lip of the bell is 7ft., with an inside length of 8ft. and a breadth of 6ft., which gives ample room for the staff. For weighting the bell, twelve cast iron blocks are attached to the sides. The total weight of the bell, exclusive of the lifting block and fittings, is 12 tons 8 cwt., the corresponding weight of displaced water being 9 tons 12 cwt. A feature of the design is the provision of four movable struts which enable the bell to be easily positioned when working on an uneven bed. The lip of the bell is protected by a steel coping. As will be seen from the drawing, there are two air supply systems, one for the bell itself, which can be regulated as regards pressure to suit the depth used in working, while the second supply is for the two pneumatic drills, spades, or other tools. Telephone communication between the barge and bell and lighting connections are provided, and the interior is equipped with movable seats, hooks for tools and equipment, and lifting shackles.

The hull, machinery and bell were constructed to the designs and specification and under the survey of Mr. Daniel Fife, M.I. Mech. E., mechanical engineer to the Clyde Navigation Trustees.

South African Engineering Notes.

(By our South African Correspondent.)

CAPE TOWN, December 14th, 1935.

Deep Mining for Gold.

For years engineers and the technical staffs of the Witwatersrand Gold Mines have been grappling with the problem of finding new methods to counteract the hot, moist atmosphere in the deep mines of the Rand. Selection of the labourers least susceptible to heat-stroke by means of test chambers, and the investigation of heat-stroke itself, have formed the medical contribution to the problem. On the engineers' side they designed a giant air-cooling plant which has now been at work in the Robinson Deep mine long enough to have proved its value. The deepest workings of the Robinson Deep are more than 8500ft. below the surface, and the air-conditioning experiment was undertaken at a cost of £100,000. Cold dry air enters the "Turf" Shaft at a rate equivalent to sending 2000 tons of ice a day underground. Already this plant has created winter conditions in summer, and, moreover, there is an important cumulation effect—the rock surfaces have been continuously chilled and should eventually reach the same temperature as the incoming air. The ultimate result of the system will be, in effect, to make the mine 1500ft. shallower. Actually, workings at 7500ft. will enjoy the conditions found at 6000ft. The question is now being asked—"Will it be possible to follow the reef down to 10,000ft.?" One prominent engineer on the mines answered the question by saying: "If spending money to provide certain conditions is not more costly than the gold recovered, then we can get down even to 10,000ft. Secondary cooling plants, known as 'boosters,' would be installed underground." About 200,000,000 tons of ore, worth £280,000,000, would be added to the gold value of the gold content of the Rand, and this represents the prize which would be won if work at 10,000ft. were made possible. It is, therefore, no exaggeration to describe recent advances in deep mining as one of the most significant phases of the Rand revival.

Union Railway's Operations.

The varied interests of the vast enterprise which the South African Railways and Harbours Administration has to control was explained recently by Mr. T. H. Watermeyer, general manager of the system. Mr. Watermeyer said the capital involved with the enterprise is £167,000,000, of which £150,000,000 is interest bearing. The annual revenue from all sources at present approximates £33,500,000, and the expenditure is much the same, as by an Act of Parliament the system is not allowed to make a profit. The general balance sheet amounts to about £34,000,000, including cash investments, stores, and equipment of subsidiary departments. Nearly 12,855 miles of railways are being operated, of which 680 miles are private lines. In addition, the system operates 10,971 miles of road motor services. The total staff employed numbers about 97,000. The Administration owns and operates seven harbours at which there are Harbour Advisory Boards. Each port is equipped with tugs, dredgers, lighters, and various other craft, besides which the Administration is responsible for several minor harbours. It owns a small line of steamers of a tonnage of 5/7000 tons, and it owns and is responsible for all lighthouses round the coasts of the Union. Also, the Administration owns and operates the Union Airways which is operated by large and fast air liners, and this part of the business is expanding, although, up to now, its operations have been carried on at a loss. The Airways service is handicapped by the sparcity of population in the Union, and the long distances between the large and important centres of population, trade, and industry. At the Census, to be taken next year, it is expected that the total population of the Union will be found not to exceed 1,900,000. Finally, it may be mentioned that the concern has a sick fund with a revenue of about £450,000.

Two Harbour Tugs Ordered.

A powerful new tug and salvage vessel has been ordered for Table Bay Harbour by the Railways and Harbours Administration, and a sister vessel is to be built for one of the other coast ports. Tenders were called some time ago and the order has now been placed with Lobnitz and Co., Ltd., of Renfrew, a firm which has previously built a number of vessels for the Administration, including dredgers and hoppers. Each tug will have a length of 146ft., breadth of 32ft., a depth of 15ft., and a gross tonnage of 550 tons. They will have two sets of triple-expansion engines, burning coal, with a total output of 2600 i.h.p., and will be among the most powerful harbour tugs in the world. The only harbour tugs of greater power afloat are the Durban tug "Sir William Hoy," of 3500 i.h.p., and the Cape Town tug, t.s. "McEwen," of 2800 i.h.p. The new tugs will have one funnel and two masts. Each ship will cost approximately £50,000, and will be fitted with the latest salvage and fire-fighting equipment. They will also be equipped with powerful wireless sets and radio telephony. The tugs are expected to be delivered about the middle of next year. Tenders are now being called by the Administration for a suction hopper dredger, to be built at an estimated cost of £100,000, for East London. It will be of 3500 tons capacity, and of the bow-well type with twin-screw machinery.

Seven New Planes.

South African Airways have placed, per the Union Government, an order with Airspeed, of England, for the delivery to South Africa early next year of seven Airspeed "Envoy" aeroplanes. Four of these machines are to be for the South African Airways for use on the feeder services which are being developed, and three are for the South African Air Force. The machines for the South African Airways are being ordered with conversion sets, enabling them to be quickly converted to military use. These Airspeed "Envoy" aeroplanes are six-seater

passenger-carrying machines fitted with two Armstrong-Siddeley "Cheetah" engines of 340 h.p. each. They will have a cruising speed of 195 m.p.h. A feature of the machines is their ability to take off in a short distance and their economical operation. Civil aviation is expected to be greatly stimulated by the latest Government offer under which a civil flying club will receive £45 for every pupil taking his "A" certificate and having fifty flying hours to his credit, while each pupil qualifying for the Air Force Reserve will receive, in addition to £25 granted when he gets his "A" certificate and has fifty flying hours to his credit, a further £90, making £115 in all. The Minister of Defence states that the Government's action is due to the tremendous advance in the development of mechanised warfare and especially of long-range heavy bombers. The Rand, he declares, could be bombed out of existence from points from which it had hitherto been considered inaccessible, and the Government had to take steps to meet the new situation.

Topographical Map of the Union.

The first sheet of the topographical map of the Union has now been completed and will be issued immediately. The scale of the map is 1–500,000ft., or nearly 8 miles to 1in. The whole of the Union is divided into nine areas, each on a separate sheet, of which this is the first. The map is being prepared by the Irrigation Department under the direction of the Director of Irrigation, assisted by an advisory board which includes the Director of Trigonometric and Topographical Surveys. The ordinary topographical survey of the country is being carried out by the Director of Trigonometric and Topographic Surveys, and the work is of a more detailed kind than the map now produced, and will take many years to complete. The Irrigation Department and the Air Force were most insistent in their demand for a topographical map and their perseverance has been successful. It was emphasised by them that thousands of pounds would be saved by the Irrigation Department, the Railway Administration, the Road Services and other departments if such a map were available, and that without such a map flying was more dangerous than it need be. The sheet includes one of the largest areas, about one-sixth of the whole of the Union. It is bounded on the north by latitude 25 deg., which passes near Warmbaths; on the south by latitude 29½ deg., which includes Bloemfontein; on the west by longitude 26 deg., which includes Zeerust, Lichtenburg, and Bloemfontein; and on the east by longitude 30 deg., which includes Ermelo and Estcourt. The Vaal River runs across the sheet, almost through the centre; Johannesburg is situated midway across the sheet and towards the upper end, and thus on this single sheet are shown some 200 miles or more of the main roads and flying routes to the ports of Cape Town, Port Elizabeth, East London, and Durban. Work on the map started in the middle of 1934, and to-day twelve field parties are at work. The Air Force has assisted with aerial photographs of inaccessible areas. The map shows the names of towns, farms, post-offices, police stations, conspicuous hills, battlefields, monuments and railways. Roads are classified in three classes, and aerodromes are shown. There is a chart of magnetic deviation, which should be useful to flying men.

Vaal River Dam Construction.

The first stage in the construction of the great Vaal Bank Dam, the biggest conservation scheme in South Africa, has just been reached with the completion of the foundations. It was a race to finish before the rains set in, which would have suspended the work for the greater part of a year. For the past three months the men worked day and night. This Vaal Bank Dam is the storage unit for the Vaal River development scheme and will conserve the flood water which will be used to irrigate 50,000 morgen of land in the Hartz River Valley, 350 miles away. In addition, the dam will ensure an adequate supply of water to Johannesburg. The Rand Water Board contributed £240,000 to the scheme. The dam will provide facilities for irrigation and the development of power along the Vaal River down to Warrenton. When completed the catchment area will be 15,000 square miles, the submerged area 40,000 acres, and the storage capacity 250,000,000,000 gallons. The concrete wall which is being constructed will be 160ft. high and 1900ft. in length, and will take 50,000 tons of cement. All the plant is being electrically driven, the power being obtained from Vereeniging power station over a transmission line 26 miles long. There are 512 white employees and 400 natives, and all are housed and fed on the works departmentally.

Cyanide Factory in the Transvaal.

Imperial Chemical Industries, Ltd., which supplies a large proportion of the cyanide used in South Africa, has been investigating the possibility of manufacturing cyanide on the Witwatersrand. The results of these investigations are favourable, and if they are confirmed in practice, African Explosives and Industries, Ltd., will undertake the manufacture of cyanide at its explosives factory at Modderfontein. It has been decided, upon the recommendation of the technical advisers of I.C.I., Ltd., to proceed at once with the erection of a pilot plant with a capacity of 500 tons, which is considered to be the most effective unit, both economically and technically, to enable production to start in the shortest possible time and to make available at an early date the data necessary for the designing and erection of a large-scale plant. In 1934 the value of cyanide imported was over £400,000 and the consumption of cyanide by the mines for the year totalled 17,287,493 lb., valued at £467,519.

Petrol Made in South Africa.

The retorts of the S.A. Mining and Refining Company were officially put into operation at the company's works at Ermelo (Transvaal) on November 22nd, by Mr. A. P. J. Fourie, Minister of Commerce and Industry, who outlined the policy of the Government in assisting the industry. The Government, he said, was determined to do all in its power to secure the continual development of the natural resources of the country. It was hoped that shortly the country would be using 50 per cent. of indigenous oil for local consumption. The privileges granted to the company were not exclusive, but would be extended to any other company prepared to proceed with the mining and refining of torbanite shales on the same conditions. It was announced during the ceremony that "Satmar" petrol would be retailed at 2d. per Imperial gallon below the tariff prices ruling. The Government had previously given an assurance that it will prevent any attempt at dumping from overseas. The company has secured the torbanite deposits in the Ermelo district, which are stated to contain at least 6,000,000 tons, and the yield, according to assays, runs from 80 gallons to 100 gallons per ton. Besides the extraction plant the company has a refining plant at Durban and considerable storage accommodation. There are other oil shales in the country, notably in Natal, and these will, no doubt, be worked if the present undertaking proves successful.

Stainless Steel.

A LECTURE on "Stainless Steels" was given by Mr. H. Bull, of Brown, Bayley's Steel Works, Ltd., Sheffield, before the Manchester Branch of the Royal Aeronautical Society on December 12th, 1935.

Mr. Bull summarised the development of stainless steel since 1912–1914 in the following manner.

In respect of the chromium steels introduced by Mr. H. Brearley, the cutlery quality has undergone no change whatsoever. A useful step in the development of this type of chromium steel was to reduce the amount of carbon, which was about 0·30 per cent. for the cutlery quality, to about 0·10 per cent. This had the effect of softening the material and making it more easily workable, particularly in the form of strip and sheet.

Steels containing smaller amounts of chromium have been used, particularly 8 per cent. chromium with 3 per cent. silicon, which is a largely used type of valve steel. Larger amounts of chromium have been used for steels and irons in nitric acid plants, where a minimum of 16·0 per cent. seems desirable. Additions of copper and nickel have been made to the higher (16/18 per cent.) chromium steels to make them tough, and in the case of the nickel to increase the tensile strength.

Higher chromium irons (20·0 per cent. chromium) have been extensively used in the electrical industries for heat-resisting purposes, and still higher contents of chromium, up to 35·0 per cent., are used for other heat-resisting duties where the free scaling temperature must be higher than, say, 1050 deg. Cent. and where stresses are low.

The fact that the chromium-nickel 18/8 type of stainless steel could be readily welded and that empirical testing methods showed the welded joint to be tough and ductile led to the material being rapidly developed. Some of its disadvantages did not show for a number of years and a most disastrous one was first described by the speaker and a colleague (Mr. L. Johnson) in the early part of 1928. The name "weld decay" then used instead of "intercrystalline corrosion" is still the most common description of the phenomenon.

Remedies, or proposed remedies, for weld decay consist of :—

(*a*) Reducing the carbon to 0·07 per cent. or less;
(*b*) Adding tungsten (about 1·0 per cent.);
(*c*) Adding titanium or vanadium (about 0·6 per cent.);
(*d*) Adding silicon (about 2·0 per cent.).

Commercially, (*a*), (*c*), and (*d*) are practised with effect. Latterly, the addition of columbium (*i.e.*, niobium) and tantalum has been sponsored from America and may have the advantage that little is lost during welding, whereas titanium and silicon may be almost completely removed by this process.

Apart from the addition of the elements to inhibit weld decay, additions of copper up to 1½ per cent. in one instance and up to 6·0 per cent. in another maker's works have been used, but to only a small extent, on account of their supposed increased resistance to small percentages of hydrochloric acid and chlorides. The addition of molybdenum in amounts ranging from 1 per cent. to 4 per cent. has been common for six or seven years, the molybdenum having the effect of increasing the resistance to sulphuric acid and to other chemicals used in the dyeing industries.

Other developments of the chromium-nickel steel have merely involved altering the ratio of the nickel to chromium, either to produce a softer alloy or one which will not work-harden so readily. A tendency has been noted to increase the nickel content of all stainless austenitic steels by roughly 1·0 per cent. This has the general effect of softening the material and rendering it less prone to some of the manufacturing difficulties in steel makers' works, and less affected by subsequent fabrication process in the users' works.

The most recent development is the introduction of an extra 3·0 or 4·0 per cent. of nickel, together with 1·50 to 2·0 per cent. of silicon, which brings about an all-round improvement in the corrosion-resisting properties and, indeed, makes the steel almost as corrosion resistant as one containing 3½ per cent. of molybdenum, with the original lower nickel content. Further, this modification has reduced the embrittlement observed when some of the weld decay-free steels which were described earlier are reheated at 650 deg. to 850 deg. Cent.

As to future developments, there are still many problems to be faced. A very notable one is that of seizure, which seems more likely to take place when two stainless steel surfaces are mated than with other steels. Such remedies as have been proposed are not infallible. The general tendency, however, is to make the mating surfaces as hard as possible, or have one hard and the other soft, and always, if possible, mate two different types of stainless steel.

In the course of the discussion Mr. Bull stated that the best method of preventing seizure between stainless steel nuts and bolts was either to make the nut of hard and the bolt of soft steel or *vice versâ*; or to use hard steel and austenitic steel together. The most certain way of causing seizure was to use steels of similar analysis. He claimed that stainless steel was readily machinable, provided that a very sharp tool was used and the cutting was continuous. As soon as a tool became dulled it should be resharpened. By allowing a dull tool to rub, considerable work-hardening took place with austenitic steels. Zirconium sulphide and selenium were among the substances which had been added to assist machining. Both of them gave rise to non-metallic inclusions, which produced a similar effect to those in ordinary high-sulphur free-cutting steel.

In conclusion Mr. Bull stressed the importance of co-operation between the steel maker and the user (in this instance the aircraft industry), as it was only by such co-operation that rapid application of the most recent results of research could be ensured.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. R. H. HARRY STANGER has taken into partnership his son, Mr. C. Harry Stanger, who has been his chief assistant for some time.

WILLIAM BEARDMORE AND CO., Ltd., announce that the address of their London office is now 3, St. James's-square, London, S.W.1.

COCHRANES (MIDDLESBRO') FOUNDRY, Ltd., have opened an office at Lombard House, Great Charles-street, Birmingham, 3, with Mr. J. W. Elliot in charge.

MR. REGINALD F. CLAYTON has resigned his position as director of Karrier Motors, Ltd., Luton. Apart from his interest in motor vehicle manufacturing, Mr. Clayton holds directorships in the Thames Valley Traction Company, Ltd.; Roberts' Castings, Ltd., Huddersfield; and Clayton and Co., of Penistone, manufacturers of railway signal appliances.

THE ANDERSON-GRICE COMPANY, Ltd., Carnoustie, has appointed Mr. C. C. Richards, A.M.I. Mech. E., 113, Hampstead Way, Golders Green, London, N.W., to represent its crane interests in London and district; and Mr. K. J. Knowles, A.M.I. Mech. E., 18a, Rowan-avenue, Whalley Range, Manchester, to represent it in the Manchester district.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

THE ENGLISH ELECTRIC COMPANY, Ltd., has received an order from the Bermuda Electric Light, Power and Traction Company, Ltd., for a 3500 b.h.p. mechanical-injection, two-stroke cycle, pump scavenge, opposed-piston, eight-cylinder, Diesel engine, running at 214 r.p.m., directly coupled to an "English Electric" alternator. This repeat order will be the fifth Diesel engine of the "English Electric" Fullagar design installed in the Bermuda station, and will bring the total power to well over 10,000 b.h.p.

CALENDARS, DIARIES, &c.

BLACKSTONE AND CO., Ltd., Stamford.—Wall calendar.

CLAY CROSS COMPANY, Ltd., Clay Cross, near Chesterfield.—Pocket diary.

CROFTS (ENGINEERS), Ltd., Bradford.—Wall calendar.

FLOWERDEW AND CO., Ltd., 227/228, Strand, W.C.2.—Calendar.

D. GILSON AND CO., Ltd., Billet Works, Billet-road, Walthamstow, E.17.—Desk calendar.

M.A.N. (MASCHINENFABRIK AUGSBURG NURNBERG, A.G.).—Wall calendar.

MATHER AND PLATT, Ltd., Park Works, Manchester, 10.—Desk pad.

PECKETT AND SONS, Ltd., Bristol.—Wall calendar.

RHODES, BRYDON AND YOUATT, Ltd., Stockport.—Greetings card.

THOMAS ROBINSON AND SON, Ltd., Rochdale.—Wall calendar.

SKEFKO BALL BEARING COMPANY, Ltd., Luton.—Wall calendar.

SUBMARINE SIGNAL COMPANY (LONDON), Ltd., 9, Victoria-street, S.W.1.—Wall calendar.

UNITED MOTORS (COIMBATARE), Ltd., Coimbatare, S. India.—Greetings card.

WAILES DOVE BITUMASTIC, Ltd., Collingwood Buildings, Newcastle-upon-Tyne.—Pocket diary.

EDWARD WOOD AND CO., Ltd., Ocean Ironworks, Manchester.—Wall calendar.

CATALOGUES.

MATHER AND PLATT, Ltd., Park Works, Manchester, 10.—Pamphlets on canning machinery, heaters, and a booklet on centrifugal oil pumps.

INTERNATIONAL COMBUSTION, Ltd., Aldwych House, London, W.C.2.—A leaflet on "Ty-Rock" mechanically vibrated screens for coarse screening.

QUEST PRODUCTS, Ltd., Wharton, Sheffield.—A booklet describing "Questox," a fluid flux which is claimed to clean and prevent oxidisation.

STURTEVANT ENGINEERING COMPANY, Ltd., 147, Queen Victoria-street, London, E.C.4.—Particulars of the Sturtevant pneumatic system of wood refuse collection.

W. RICHARDS AND SONS, Ltd., Britannia Foundry, Middlesbrough.—The sixteenth annual chart issued by the firm showing the prices of iron and steel from 1914 to 1936.

MUREX WELDING PROCESSES, Ltd., Ferry Lane Works, Forest-road, E.17.—A publication entitled "The Maintenance of Permanent Way on Railways by Electric Arc Welding."

GEO. H. ALEXANDER MACHINERY, Ltd., 82, Coleshill-street, Birmingham, 4.—Particulars of the Carpenter torsion impact testing machine for which the company are agents in this country.

PARIS INTERNATIONAL TRADE FAIR.—The Paris Trade Fair, to which we referred in our issue of January 3rd, will open on May 16th, and not on the 26th as inadvertently stated.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Problem of Controlling Steel Imports.

Discussions between the British and Continental steel makers took place at Brussels at the beginning of the week at which the method of distributing steel imports into Great Britain was considered. At the beginning of December the Continental steel makers were informed at a meeting held in London of the British proposals. These included the purchase of the Continental imports by the newly formed British Iron and Steel Corporation, their resale to the Continental sales organisations in this country and the supervision of the distribution by committees representing both the British and Continental interests. Meetings of the Cartel steel makers were held in Brussels last week, at which this plan was considered preparatory to the meeting with the British makers. Although no official announcement has been made, it is gathered that the Continental makers are very much averse to several features of the British scheme. They do not, for instance, wish to sell their steel *en bloc* to the Corporation. It is probable that they will suggest an alternative plan which will include the setting up of a joint statistical office in London to supervise and control the imports. Their selling organisations in this country also would work under carefully drawn up regulations designed to meet the British steel makers' desire for effectual control of the steel after it is imported. It is doubtful, however, if these proposals will entirely meet the British makers' views. The market is somewhat nervous as to the consequences which might follow a disagreement, as the terms in which the announcement made at the end of December that the duties would remain at 20 per cent. for an indefinite period subject to review created the impression that they might be raised if the British steel makers were dissatisfied with the outcome of the negotiations. Rumours have been current in the market that Continental steel prices for export were reviewed at the Brussels meeting and that it was decided to make certain increases, but no changes have been announced. It is known also that there is a feeling amongst British steel makers that, notwithstanding recent advances in the export prices of many descriptions of British steel, quotations might reasonably be raised for several export markets, it seems probable that both parties may be in agreement upon this point.

The Pig Iron Market.

Business in the pig iron market has been resumed on normal lines following the dislocation caused by the holidays. The outlook, however, is disturbed by the coal crisis, and the uncertainty arising from this is reflected in the increased reluctance of producers to undertake forward commitments. Apart from the possibility of supplies of fuel being interfered with by the dispute, the proposed increase in the cost of coal has upset the iron and steel price position, and for a few weeks at least the market is likely to be unsettled. On the North-East Coast the makers seem to be unable to enter into any further commitments. The whole output of foundry iron is passing into consumption, and the makers' stocks are negligible. The three furnaces producing foundry iron on this coast cannot meet the requirements of the market, and increased quantities of Midland irons are likely to be brought into the district to make up the deficiency. The demand for Cleveland foundry seems to be expanding, and the engineering industries, as well as the foundries, would take much more of this description than they find it possible to obtain. In the Midlands the market is as active as it was immediately before the holidays, and it is claimed that there are good grounds for expecting that the deliveries in January will be upon the same scale as during the past two months. Whilst the stocks of Northamptonshire iron are not heavy, there are considerable accumulations at some of the Derbyshire furnaces, so that there is no stringency in the market for these brands. Anticipations are current, however, of an increase in prices when the producers' Association meets this month. In Lancashire, the market has been steady. Comparatively little new business has been transacted in foundry iron, but this is attributed largely to the stocktaking operations which have been in progress at many of the consuming works. The worst feature of the position in this district is that the textile machinery makers are not well off for business, and are taking comparatively small supplies. In the Scottish market business was resumed this week following the New Year holidays on steady lines, and the production of the five furnaces operating in Scotland is being absorbed. New business, however, is rather quiet. It is expected that this year the production of pig iron in Scotland will amount to about 400,000 tons. The situation in the hematite market is unchanged. Expectations of an advance in price have not been fulfilled, but the market appears to think that this will take place during the next few weeks.

The North-East Coast and Yorkshire.

The activity at the steel works on the North-East Coast was scarcely interrupted by the holidays, and with the exception of some stoppages for repairs the mills remained in operation. It is many years since the North-East Coast steel makers have entered upon a New Year with such heavy order books. In the semi-finished steel department, in particular, the market requirements are in excess of the capacity of the works, and in some cases producers are badly behind in deliveries. A heavy tonnage of billets and sheet bars is being turned out, but the output is understood to be earmarked for a long time to come. Next to semis the demand for structural steel materials appears to be the most urgent and some mills are unable to keep pace with their delivery dates. Several rather important contracts for joists and constructional steel are expected to be placed early in the New Year, so that the outlook so far as this branch of the industry is concerned is exceptionally promising. The recent increase in the price of sheets has held up business to a certain extent, as consumers apparently feel that no further alterations need be expected and are therefore content to mark time. The plate mills are not as well occupied as most other departments, but it is probable that the recent shipbuilding contracts placed on this coast will be reflected in a stronger demand for this material. Business in the Yorkshire steel markets has been active since the holidays, and a number of good inquiries are reported to be in circulation. Consumers are trying to cover their forward requirements as far ahead as possible. Many of them are showing anxiety to place fresh business owing to the possibility of a dislocation of operations in the steel industry as a result of trouble in the coalfields. The demand for acid carbon steel billets shows no signs of declining, whilst in the lighter steel section of the market there has been a vigorous request for special steels. The motor car and cycle manufacturers, also, are providing an outlet for a good tonnage of steel material. Business in wire rods has been maintained at a high level and this department is working practically at capacity. In the scrap market a feature of the position has been the tendency of prices to advance, although this movement is not so noticeable in Sheffield as in some of the other steel-producing areas.

The Midlands and South Wales.

A considerable amount of inquiry made its appearance in the market following the holidays. The constructional engineers, who for the most part have contracted heavily for the next few months, are busily employed, and are expected to place good orders for constructional steel shortly. Complaint is heard from some engineering firms of the difficulty of obtaining deliveries from the steel works on time; but the requirements of this industry have been exceptionally heavy for some weeks. Whilst there has been an improvement in the demand for plates, this section of the industry is not so well employed as it might be. Business in sheets, however, promises to be maintained, although slightly checked by the recent advance in prices. The re-rolling industry has been working at capacity for weeks past; but the restart after the holidays was somewhat irregular and some works complained that they were unable to maintain as high a rate of operation as the state of their order books would warrant owing to the difficulties of obtaining regular supplies of semi-finished steel. The demand for small bars and strip shows no signs of relaxing. There is no change in prices and both associated and non-associated works quote the same figure. For strip the quotation is £9 7s. d/d. and for bars £8 12s., less a rebate of 2s. 6d. to 5s. The activity in the demand for bright-drawn steel bars, noticeable before the holidays, continued when work was resumed, the official quotation being unchanged at £13 10s. basis. Business in colliery steel has been coming forward in satisfactory volume for some time, although many collieries are well covered forward. No changes have occurred in the quotations of £8 15s. for heavy arches and £8 5s. for light, but it is not always easy to find works willing to do business at these rates. In South Wales a good demand for tin-plates from home consumers is being experienced. This industry is taking a heavy tonnage of semis and at some of the works producing this class of material the holidays were curtailed in order to enable them to overtake arrears in deliveries. The quotation of £5 10s. for sheet and tinplate bars has been unchanged for a long period and production in this department is on a heavy scale. The works producing structural steel in South Wales have been busy and lately there has been a good demand for steel materials from the ship-repairing yards.

Current Business.

The new steel works of the British (Guest, Keen, Baldwins) Iron and Steel Company, Ltd., at Cardiff, which have been reconstructed at a cost of £2,000,000, commenced operations on January 2nd. The works have thus started according to the schedule laid down when the reconstruction was commenced. The Hughes-Bolckow Shipbreaking Company, Ltd., of North Blyth, has purchased two steamers—the "Vagliano," 4734 tons, and the "Gantoise," 3939 tons—for breaking up. The vessels have been acquired under the Government "scrap and build" scheme. The breaking up of the White Star liner "Doric" has been commenced at the yard of John Cashmore, Ltd., metal merchants, of Newport, Mon. War Office contracts for steel rounds, billets, and files have been placed with Brown Bayley's Steel Works, Ltd., Sheffield; Samuel Fox and Co., Ltd., of Stocksbridge; the Park Gate Iron and Steel Company, Ltd., Park Gate, Rotherham; and the English Steel Corporation, Ltd., Sheffield. Orders for rasps have been placed by the War Office with Thomas Firth and John Brown, Ltd., Sheffield, and Sanderson Brothers and Newbould, Ltd., of Sheffield. Machinery to tap new areas of coal is being installed by the Shotts Iron Company, Ltd., at their Loanhead and Roslin collieries, Midlothian. H. S. Marsden, Ltd., of Leeds, manufacturers of stone-breaking and ore-crushing machinery, which was founded seventy-three years ago, has been reorganised and a new company formed. As a consequence of the affiliation of the bridge and structural steelwork industry to the British Iron and Steel Federation, certain modifications in the constitution will be required to conform to the progress of general reorganisation. Negotiations therefore are proceeding as to the best means of strengthening the co-operative work of the British Steelworks Association on propaganda and market development. The Department of Overseas Trade announces that the following contracts are open for tender:—Egypt, Roads and Bridges Department of the Ministry of Communications, construction of a steel swing bridge (Cairo, January 22nd); Ministry of Public Works, electric washing machines and electric hydro extractor (Cairo, January 28th); lathes, grinding machines, &c. (Cairo, February 1st); 2500 kilos. of galvanised steel plates, 10,000 kilos. of mild steel angles, 1200 kilos. of short link iron chain, 4660 kilos. of hexagonal iron bolts and nuts, and 1850 kilos. of pan-headed rivets (Cairo, February 4th). Indian Stores Department, two portable turbine pumping sets, oil engine driven (New Delhi, February 4th). South Africa, Public Works Department, oil fuel steam boilers, feed pumps, and automatic equipment (Cape Town, February 7th).

Copper and Tin.

The electrolytic copper market has barely recovered from the interruption to business caused by the holidays and few features of importance have developed. In America consumers have bought with a certain amount of freedom, but contrary to expectations the producers have not yet raised their domestic quotation from the 9¼ c. level. It is possible that an upward movement will not take place until the markets in Europe have developed a stronger tone than prevails at the moment. The market, however, is facing the future with confidence, and it would not be surprising if a substantial buying movement developed. Consumers in Europe are believed to be working upon small stocks which it will be necessary to replenish in the early weeks of the New Year. Buying by the consuming industries in Great Britain has been steady, and last week the War Office bought 200 tons of electrolytic copper. With this exception, no individual transactions of importance have been reported. Statistically, the position is favourable, and production has been restricted to a point which is enabling the long-standing accumulations of the metal to be liquidated. Once these stocks, which amount to about 476,000 tons, are more normal, it is generally anticipated that prices will show a considerable appreciation. In the standard market business has been of a rather humdrum character since the holidays. Stocktaking influences have been partly responsible for this, and, as often happens at the beginning of the year, speculators are inclined to hold aloof. The slightly easier tone which developed occasionally did not go far, as support for the market was always forthcoming. . . . Contrary influences have been noticeable in the tin market this week. Whilst the statistics for December showed a reduction in the visible supply at the end of the month of 1272 tons to 12,305 tons, the prospects of increased supplies, due to the quota having been raised to a 90 per cent. basis, has created a weaker tone. Supplies in December were 8765 tons, compared with 10,632 tons in November, whilst the deliveries amounted to 10,037 tons in December, against 9187 tons in the previous month. It might have been expected that these favourable figures would have been followed by an advance in prices, but actually the reverse took place, which may be taken as an indication that the market expects the increased supplies to make their appearance early next month. It is, of course, impossible for the full effect of the last rise in the quota to be experienced before March and probably later. In the meantime the backwardation has varied between £8 and £10, and is still acting as a check upon hedging and speculative business.

Lead and Spelter.

After a period of rather depressed markets, lead prices have shown a slightly firmer tendency. The present is usually the quietest period of trading in this department, but this week interest on the part of the consuming industries has revived slightly, and this may lead to the development of a more confident tone. Not many weeks ago the general view seemed to be that the lead price might pass the £20 mark, but latterly there has been a noticeable inclination to take a rather pessimistic view of the outlook. It is reported that production in Mexico after the strike has been on a larger scale than was expected, whilst the probability of an increase in the Australian output this year has naturally created some doubt as to the probable course of the market. The slump in silver, however, may affect the production of lead, since it will make silver-lead ores less profitable to work. Continental buying, which was a feature of the market in November and the early part of December, has declined, and it is suggested that Italian requirements have been satisfied for the time being. The statistical position of the market is favourable. The American figures give the stocks at the end of November as 222,236 tons, compared with 225,309 tons at the end of October. The world's production of lead in November was 148,000 tons, compared with 132,000 tons in October. . . . The spelter market fails to develop any feature of interest and the price movements seem to follow largely the changes in the lead quotation. In America the position is entirely different; a strong demand exists and stocks seem to be falling steadily. So complete is the isolation of the American market, however, that this has practically no influence upon prices here. The demand has shown few signs of reviving since the holidays, and anticipations that business on the Continent would be resumed on a good scale in January have failed to materialise. Buying by the principal consuming trades has been interfered with owing to so many concerns having been engaged in stocktaking; but from now on business in this market should become more normal. The American statistics give the world's production in November as 124,166 tons compared with 125,977 tons in October.

Current Prices for Metals and Fuels.

Makers' official home trade prices per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. COAST—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 10 6	3 2 0
No. 1	3 11 0	3 3 6
Cleveland—	(*D/d Teesside Area*)	
No. 1	3 12 6	3 4 0
No. 3 G.M.B.	3 10 0	3 1 6
No. 4 Forge	3 9 0	3 0 6
Basic (*Less 5/– rebate*)	3 10 0	—
MIDLANDS—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 15 0	—
„ „ Forge	3 10 0	—
Basic (*Less 5/– rebate*)	3 15 0	—
Northampton—		
Foundry No. 3	3 12 6	—
Forge	3 7 6	—
Derbyshire—		
No. 3 Foundry	3 15 0	—
Forge	3 10 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 13 6	—
No. 1 Foundry, ditto	3 16 6	—
No. 3 Foundry, ditto	3 14 0	—
Basic, d/d (*Less 5/– rebate*)	3 10 0	—
N.W. COAST— Hematite Mixed Nos.	3 14 0 d/d Glasgow	
	3 18 6 „ Sheffield	
	4 4 6 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
LANCS.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. YORKS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
MIDLANDS—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
No. 3 quality	7 17 6	—
No. 4 „	8 10 0	—
SCOTLAND—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. COAST—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

	Home.	Export.
LONDON AND THE SOUTH—	£ s. d.	£ s. d.
Angles	8 10 0	7 10 0
Tees	9 10 0	8 10 0
Joists	8 17 6	7 10 0
Channels	8 15 0	7 15 0
Rounds, 3in. and up	9 10 0	8 10 0
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¾in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ 7/16in.	9 15 0	8 10 0
„ ⅝in.	9 10 0	9 0 0
NORTH-EAST COAST—	£ s. d.	£ s. d.
Angles	8 7 6	7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	7 10 0
Channels	8 12 6	7 15 0
Rounds, 3in. and up	9 7 6	8 10 0
„ under 3in.	8 12 0	7 10 0
Plates, ¾in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ 7/16in.	9 10 0	8 10 0
„ ⅝in.	9 10 0	9 0 0
Boiler Plates, ¾in.	9 5 0	—
MIDLANDS, AND LEEDS AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	7 10 0
Channels	8 12 6	7 15 0
Rounds, 3in. and up	9 7 6	8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ 7/16in.	9 12 6	8 10 0
„ ⅝in.	9 5 0	9 0 0
Boiler Plates, ¾in.	9 7 6	7 15 0

STEEL (*continued*).

	Home.	Export.
GLASGOW AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	7 10 0
Channels	8 12 6	7 15 0
Rounds, 3in. and up	9 7 6	8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ 7/16in.	9 10 0	8 10 0
„ ⅝in.	9 5 0	9 0 0
Boiler Plates	9 5 0	—
SOUTH WALES AREA—	£ s. d.	£ s. d.
Angles	8 7 6	7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	7 10 0
Channels	8 12 6	7 15 0
Rounds, 3in. and up	9 7 6	8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ 7/16in.	9 12 6	8 10 0
„ ⅝in.	9 10 0	9 0 0

IRELAND—	BELFAST. £ s. d.	REST OF IRELAND. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¾in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ 7/16in.	9 15 0	9 17 6
„ ⅝in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G. to 13-G., f.o.r.	9 15 0	9 0 0
14-G. to 20-G., d/d	11 5 0	9 10 0
21-G. to 24-G., d/d	11 10 0	9 15 0
25-G. to 27-G., d/d	12 2 6	10 7 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 10 0
2-ton to 4-ton lots	13 17 6
Under 2 tons	15 10 0

Export: £12 15s. 0d., c.i.f. India.
„ £11 15s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18s. 9d.
Tin-plate Bars, d/d South Wales Works, £5 10s. 0d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 to 250 tons	5 17 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 0 0	7/–
„ „ 8 p.c. to 10 p.c.	£21 0 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£33 10 0	11/–
„ „ „ 1 p.c. carbon	£36 5 0	11/–
„ „ „ 0·50 p.c. carbon	£37 5 0	12/–
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose), 76 p.c.	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, January 8th.

COPPER—	
Cash	£34 13 9 to £34 16 3
Three months	£35 2 6 to £35 3 9
Electrolytic	£39 0 0 to £39 5 0
Best Selected Ingots, d/d Birmingham	£38 15 0
Sheets, Hot Rolled	£66 0 0

	Home.	Export.
Tubes, Solid Drawn (basis)	10½d.	10½d.
„ Brazed (basis)	10½d.	10½d.

BRASS—	
Ingots, 70/30, d/d Birmingham	£32 0 0 to £33 0 0

	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9½d.	9½d.
„ Brazed	11½d.	11½d.

TIN—	
Cash	£211 10 0 to £211 12 6
Three months	£202 10 0 to £203 0 0
LEAD	£15 7 6 to £15 10 0
SPELTER	£14 10 0 to £14 15 0
Aluminium Ingots (British)	£100

FUELS.

SCOTLAND.

LANARKSHIRE—	Export.
(f.o.b. Grangemouth)—Navigation Unscreened	18/– to 18/6
Hamilton Ell	19/– to 19/6
Navigation Splints	20/– to 21/–
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/– to 16/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	17/6
Unscreened Navigation	18/– to 18/6
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime	17/6
Secondary Steam	16/6

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	14/6 to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	15/6 to 16/6
„ Second	14/6 to 15/–
„ Best Small	11/–
Unscreened	13/– to 14/6
DURHAM—	
Best Gas	14/8
Foundry Coke	19/– to 20/–

SHEFFIELD—	Inland.	
Best Hand-picked Branch	26/– to 28/–	—
South Yorkshire Best	23/– to 25/–	—
South Yorkshire Seconds	20/– to 21/–	—
Rough Slacks	11/– to 12/–	—
Nutty Slacks	10/– to 11/–	—

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	19/6
Best Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Bunker Smalls	12/6 to 13/6
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 27/6
Foundry Coke	27/– to 40/–
Furnace Coke	19/– to 22/6
Patent Fuel	21/–
SWANSEA—	
Anthracite Coals:	
Best Large	36/– to 40/–
Machine-made Cobbles	45/– to 48/6
Nuts	40/– to 48/6
Beans	25/– to 30/–
Peas	19/– to 23/–
Rubbly Culm	11/– to 11/6
Steam Coals:	
Large Ordinary	18/– to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3¼d.
Diesel Oil	4d.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Year's Outlook.

IT generally happens that fluctuations of the French economic system lag behind those of other countries, in the sense that trade declines after a depression has accentuated elsewhere and takes time to fall in step with a recovery that may already have gained impetus abroad. An explanation of this phenomenon is the country's partial self-dependence and huge monetary reserves that remain concealed in times of stress and only go into circulation when all danger is passed. At present, the industrial recovery in Great Britain and better prospects in the United States are regarded as offering more encouragement to French trade during the present year. But there are adverse factors arising out of the troublous times, with their problems and perplexities, which weaken public confidence and destroy private initiative. Elements of a trade recovery exist if they can be given normal play. Stocks of all manufactured goods are low because sellers will not place orders with makers when they find the public reluctant to buy. Owing to want of confidence money will not circulate and is far too dear for industrial requirements. So long as the situation is dominated by a desire to prevent a devaluation of the franc there can be no hope of industry being provided with financial help without currency stabilisation. In its national economy programme the Government declared that further revenue could only be obtained by increasing imports and exports, and while having the will to carry out that plan it can make little progress against the opposition of manufacturing interests, which insist that import duties shall be high enough to give them the same protection as quotas. In the opinion of the French there can be no general trade expansion without a world stabilisation, which still appears to be a long way off, and they can only see hope of revival on the Continent by reciprocal trading amongst countries that have more or less stabilised currencies and undertake to suppress dumping methods. So completely disorganised is the Continental economic system that it is believed to be only possible to put it into operation again gradually, and so far as France is concerned efforts will continue to be made during the year to bring about that gradual recovery, while there is reason to believe that the internal reforms carried out during the past few months will be productive of more industrial activity at home.

Coal Strikes.

The threatened strike in the British coal industry is causing less uneasiness in this country than had been experienced on previous similar occasions, for, apart from anthracite and bunker coal, which have the advantage of quality and convenience of supply, there is no longer complete reliance on British coal when low freights enable other countries to provide all that is needed. Consumers are only worried at the prospect of a stoppage of British supplies putting up prices of coal from other sources. If this were the only result of a strike the consequences would not be serious for British coal owners, but it cannot be overlooked that a permanent loss of trade has followed every strike in the past. After the Armistice, Great Britain was the only country able to supply the Continent with coal, and prices reached a level that aroused resentment amongst the French, who began to see the necessity of making the best of their own coal reserves. The climax came with the strike in 1926, when all coal-producing countries were ready to make up for the deficiency. The permanent loss to British coal owners was 10,000,000 tons a year. The production of French collieries was increased to what is regarded as a maximum of 50,000,000 tons, or two-thirds of the home consumption in normal times. In these days, when methods are employed to make the fullest use of fines and poor quality coals and electrification is steadily reducing the coal consumption, it is dangerous to introduce elements of uncertainty in the coal trade in face of severe foreign competition.

Refuse Incineration.

Local opposition to refuse incineration stations has to be taken into account by municipalities, which, nevertheless, can override such opposition when schemes are approved by the Council of Health. In the case of the suburban town of Puteaux a refuse-destroying plant is to be installed near the Neuilly bridge on the avenue stretching from the Arc de Triomphe to the Defense monument at Courbevoie. The avenue is being converted into a "triumphal highway" in commemoration of past national events, and the Neuilly bridge will be rebuilt and widened in consequence. The inhabitants of Puteaux are protesting against the erection of an incineration station near the avenue. There are also protests at Issy-les-Moulineaux against smoke and fumes discharged from the incinerating station there, and at the General Council of the Seine a motion was adopted in favour of suppressing refuse incineration in the Department of the Seine, but that motion was merely intended to air a real or fancied grievance. The only result of this agitation will be to turn the attention of municipalities to more efficient methods of smoke abatement.

Street Signals.

A method of luminous street signalling was tried experimentally in Paris for a long time before it was extended in a manner that seems likely to be followed by its adoption all over the city. At a street crossing there are coloured lights on black panels, somewhat similar to the new railway signals, and these lights are operated either by hand in the more congested places, or automatically in the less frequented streets. In the latter case, contacts traverse the road at a distance of about 50 yards from the crossing. A car running over the contacts switches red lights on to the cross road, and on reaching the contacts beyond the crossing the lights show green for a few seconds, after which occulting yellow lights indicate "all clear." The system appears to be working quite satisfactorily, and observation shows that car drivers take care to avoid overrunning the signals.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

ELECTRICAL APPLIANCES.

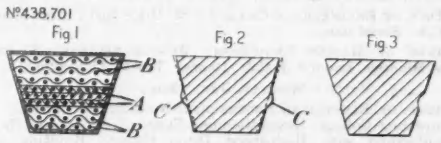
438,706. June 26th, 1935.—RESISTANCE MATERIALS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

The present invention concerns resistance materials, particularly suitable for excess voltage leaks consisting of mixtures of conducting and semi-conducting materials, such as graphite and silicon-carbide, with gypsum or Sorel-cement, which serves as a binding medium. These binding media have the advantage that they set quickly at an ordinary or moderately high temperature, and after having set, they require no further subsequent treatment. According to the invention, the gypsum or Sorel-cement are not each employed singly, but magnesium oxide (*i.e.*, the main constituent part of the Sorel-cement) is admixed with the gypsum. The limits of the additions of MgO to the gypsum are not sharply defined, but it is advisable not to exceed a proportion by weight of magnesium oxide to the gypsum of 1 : 2, in order that the resistance body may not become too sensitive to the effect of dampness. Other oxides, such as Al_2O_3, Be_2O_3, or TiO_2 can be employed instead of the MgO.—*November 21st*, 1935.

TRANSMISSION OF POWER.

438,701. June 12th, 1935.—V. BELTS, Società Italiana Pirelli, 21, Via Fabio Filzi, Milan, Italy.

It is urged that V belts as ordinarily made—that is to say, as shown in Fig. 1, with a cord centre A and fabric fillings B B—fail through the core spreading, as shown in Fig. 2, and wearing locally at C C. The makers consequently make the belt with initial grooves at these points—see Fig. 3. This belt is an endless one, having a diameter of about 740 mm. It has a resisting

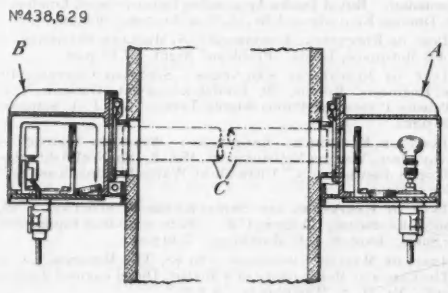


core, composed of three layers of rubberised cord fabric, interposed between four layers of rubberised cloth above the core and four below, these layers of rubberised cloth constituting the filling layers of the belt. When the belt is at rest, the angle of taper of the sides is 40 deg. in the upper part of the belt section and 32 deg. in the lower part, the angle of taper of the groove of the pulley with which the belt is designed to be used being about 28 deg.—*November 21st*, 1935.

MEASURING AND TESTING INSTRUMENTS.

438,629. September 26th, 1934.—MEASURING THE DENSITY OF SMOKE, Elliott Brothers (London), Ltd., Century Works, Lewisham, and L. W. Pettitt, 8, Hayes-road, Bromley.

In instruments for measuring the density of the smoke passing up a chimney of the type in which a beam of light is passed through the smoke to act on a selenium cell, the



readings are liable to be disturbed by soot being deposited on the windows of the apparatus. The inventors consequently mount the lamp box A and the cell box B on hinges, so that they may be swung clear. A tube C is then passed through the chimney and the instruments reinstated. A reading can then be taken through clean air and the zero adjusted to allow for any dimming of the glasses.—*November 20th*, 1935.

LIGHTING AND HEATING.

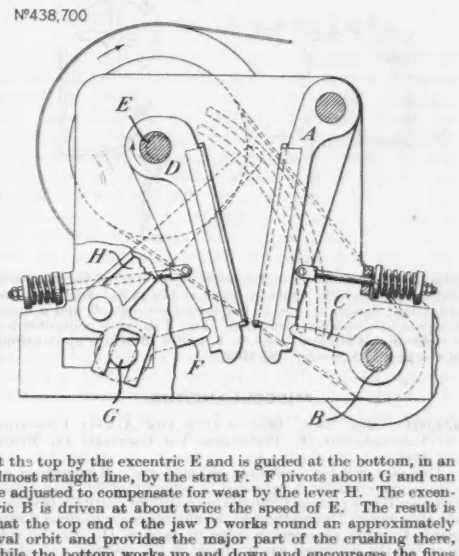
438,008. May 22nd, 1935.—THE MANUFACTURE OF COMPRESSED CARBIDE BODIES, *F. G. Brettell, Furnival House, 14–18, High Holborn, London, W.C.1.*

The manufacture of compressed bodies of carbide, made of calcium carbide in minute granular form, and mixed with a binding medium and impregnated with oil, for the generation of comparatively small quantities of acetylene gas in portable apparatus is known. The known compressed carbide bodies, as hitherto customarily used, are not suitable if the gasification system is used, wherein the gas developing water is supplied in droplets, because it is in this case possible for water to accumulate in the interstices between the individual carbide granules, and this can cause a sudden excess generation of the acetylene gas. According to the invention a compressed carbide body is manufactured from finely granulated carbide by a process in which the carbide granules are heated to a temperature of from 100–150 deg. Cent., and are impregnated at this temperature with a viscous hydrocarbon oil, the above mixture being thereupon mixed thoroughly with a meltable binding medium, which is either soluble in or at least easily miscible with the impregnating medium (*i.e.*, hydrocarbon oil), the binding medium being, for instance, sulphur, pitch, or asphalt. The mixture thus obtained is finally compressed in dies or the like to the desired shape. With compressed carbide bodies manufactured according to this process, the water which is allowed to drip on them in the form of droplets acts on them exclusively from the outside, and the gasification is very considerably retarded, thereby allowing a very uniform and complete decomposition to be attained, the residue left being in the form of powder. Even if the generation of acetylene is temporarily stopped by cutting off the water supply, the after formation or evolution of gas is stopped almost completely. Example :—100 kilos. of calcium carbide in granules of a size of from 1–4 mm. are heated to 130 deg. Cent., and are intimately mixed with 4 kilos. of viscous crude hydrocarbon oil. Thereupon 3 kilos. of ground stick or roll sulphur and 3 kilos. of pitch are mixed into the hot mass, this mass being then, after a thorough and intimate intermixing, pressed in suitable dies into cylindrical bodies of 50 mm. diameter, 40 mm. height, and provided with a central hole, on a press at a very high pressure.—*November 8th*, 1935.

MINING MACHINERY.

438,700. May 31st, 1935.—JAW CRUSHERS, T. W. Keet, 20, Victoria-building, Commissioner-street, Johannesburg, Transvaal Province, Union of South Africa.

The object aimed at in this crusher is to facilitate the discharge of the crushed fines and still maintain a large output. The machine has two movable jaws. One of them, A, is pivoted to the frame at the top and is reciprocated at the bottom by the excentric B and pitman C. The other jaw D is reciprocated

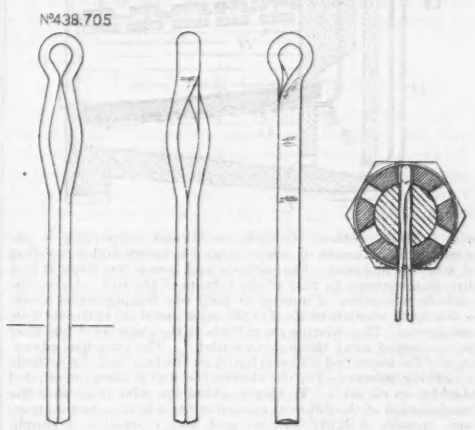


at the top by the excentric E and is guided at the bottom, in an almost straight line, by the strut F. F pivots about G and can be adjusted to compensate for wear by the lever H. The excentric B is driven at about twice the speed of E. The result is that the top end of the jaw D works round an approximately oval orbit and provides the major part of the crushing there, while the bottom works up and down and encourages the fines to flow out. At the same time the jaw A produces a crushing action in that locality.—*November 21st*, 1935.

MACHINE TOOLS AND SHOP APPLIANCES.

438,705. June 26th, 1935.—SPLIT PINS, P. C. Puttick, 29, Lodge-avenue, East Cosham, Portsmouth.

This split pin is made in exactly the same way as ordinary split pins, but with the addition of a bow in each of the legs immediately below the head of the pin, as shown in the drawings. The bow overall is of the same width as the head of the pin, and three times the width of the head in length. These proportions hold good for all sizes of pins. When the correct size of split pin is driven into any hole prepared to receive it, the ends of the pin will automatically open out as they come through the other end of the hole. The spring tension holds the pin firmly in position in the hole, and the ends of the pin being already partly open can be knocked over immediately.—*November 21st*, 1935.



METALLURGY.

438,633. December 7th, 1934.—IRON ALLOYS OF NON-FERROUS METALS, Fried. Krupp Grusonwerk Aktiengesellschaft, Magdeburg-Buckau, Germany.

The process may be explained by means of an example. An oxidic nickel ore with about 1 per cent. nickel and 10 per cent. iron was treated. The gangue of the ore, which consists of serpentine, does not permit of a treatment of the material in the usual smelting operation, as considerable additions would be necessary for slagging the high magnesia and silicic acid content. The ore was treated with an addition of 20 per cent. fine-grained fuels in a rotary furnace process. The working conditions in the furnace were so adapted that the nickel and a great part of the iron oxides were reduced to metals becoming welded together at temperatures of about 1200 deg. to 1300 deg. Cent. under the action of an oxidising heating flame to form metallic lumps or nodules embedded in the only semi-soft slag. By magnetic treatment it was possible to produce a nickel-iron concentrate from the discharge of the furnace, which concentrate contained about 10 per cent. nickel in addition to 80–85 per cent. iron. The non-magnetic final slag had a nickel content of 0·1 and an iron content of about 6 per cent. The further treatment of the nickel-iron alloy may be effected by usual metallurgical methods to produce pure nickel or a ferro-nickel alloy. The process is chiefly suitable for the production of iron alloys of non-ferrous metals whose oxides have a smaller or only a slightly greater heat tone than the oxides of iron—that is to say, all metals whose reduction from oxidic combinations is easier or only slightly more difficult to carry out than the reduction of iron.—*November 20th*, 1935.

BUILDING.

437,932. May 17th, 1935.—SHEET STEEL PILING, Fried. Krupp Aktiengesellschaft, Essen, Germany.

This is a system of piling in which the piles are connected together by separate rolled members or elements. Fig. 1 shows an element for connecting a branch wall to the main wall of

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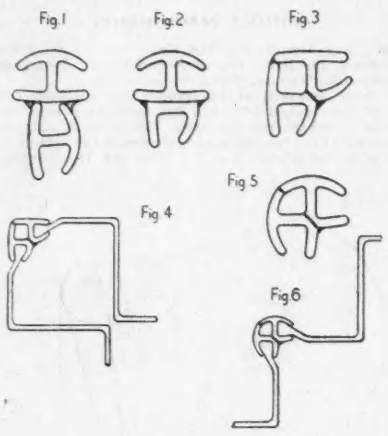

piling. It comprises two H section pieces welded together and leaving slots for the bulbous edges of the piles. In Fig. 2 the redundant flanges of one H bar have been cut off and a more compact arrangement provided. Fig. 3 shows a connector for a right-angled corner. Figs. 4, 5, and 6 illustrate applications of the idea.—*November 7th*, 1935.

MISCELLANEOUS.

438,009. May 23rd, 1935.—CELLS FOR ALKALI CHLORIDE ELECTROLYSIS, P. Pestalozza, Via Guerrazzi 17, Milan, Italy.

This is a cell for producing chlorine gas. It comprises an electrolysis chamber A arranged in communication with a side chamber B by a passage C formed in an upright partition between the chambers. The bottoms of the chambers are inclined downwards towards an overflow pipe or syphon D. In the side chamber the hydrogen gas produced at the cathode, and which enters the chamber B through an aperture E in the partition, is carried away upwards through a conduit F, while the caustic alkali recovered simultaneously collects in the bottom of the chamber. In the electrolysis chamber A is arranged a woven

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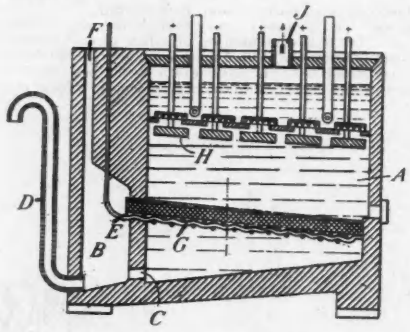

wire grid-like cathode G underneath and supporting a gas screen which consists of a woven wire network and a covering of asbestos material. The cathode and screen are inclined in a direction opposite to that of the bottom of the cell. Above the cathode a number of anodes or only one homogeneous anode is arranged, which is inclined in the same direction as the cathode and screen. The chlorine gas collects in the chamber A and may be conducted away through an outlet J. The principal advantage of the improved screen is based on the fact that the cathode is entirely submerged in the electrolyte, and is thus surrounded thereby on all sides. To this is added the advantage that the combination of the different elements into a homogeneous structure ensures stability thereto and also represents a simplification in construction.—*November 8th*, 1935.

438,011. June 7th, 1935.—NUTS AND BOLTS FOR THIN SHEET METAL, L. W. Post, 92, West Albemarle-avenue, Lansdowne, Pennsylvania, U.S.A.

This is a nut for bolting on to sheet metal partitions, the rear facet of which are inaccessible, any desired fitting. It

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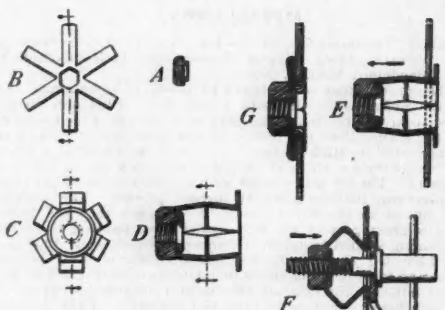


comprises a nut A on to which a star-shaped stamping B is riveted. The arms of the star are then bent over as shown at C and D. The device can then be passed through a hole in the partition, as shown at E, and buckled up by a temporary screw F, so as to appear as at G ready for service.—*November 8th*, 1935.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

CHEMICAL ENGINEERING GROUP.—At Chemical Soc., Burlington House, W.1. "The Handling and Use of Liquid Chlorine," Mr. F. Holt. 8 p.m.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN STUDENTS.—Armstrong College, Newcastle-upon-Tyne. "Automatic Control Systems," Mr. H. B. Topham. 7.15 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Thomas Lowe Gray Lecture, "The Future of Steam Propulsion," Mr. J. Johnson. 6 p.m.

INST. OF PRODUCTION ENGINEERS: LONDON SECTION.—British Industries House Club, Marble Arch. W.1. "Machine Tool Tests and Alignments," Dr. Georg Schlesinger. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Refractory Materials," Dr. J. H. Partridge. 7.30 p.m.

KEIGHLEY ASSOC. OF ENGINEERS.—Queen's Hotel, Keighley. "The Foundry and the Engineer," Mr. J. Roxburgh. 7.30 p.m.

MANCHESTER ASSOC. OF ENGINEERS.—At Engineers' Club, Manchester. "High-speed Oil Engine for Industrial Power Plants," Mr. A. C. Yeates. 7.15 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—At Mining Inst., Newcastle-upon-Tyne. "Relation of Laboratory Research to Engine Design," Dipl.-Ing. H. Hauttmann. 6 p.m.

SATURDAY, JAN. 11TH.

INST. OF AUTOMOBILE ENGINEERS.—Graduates' visit to works of Tecalemit Ltd., Great West Road, Brentford. 2.30 p.m.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN STUDENTS.—Visit to Close Power Station of Newcastle and District Electric Lighting Company, Ltd. Visitors will meet outside Library of Literary and Philosophical Soc., 2.30 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Visit to Post Office Telephone Exchange, Leeds.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND CENTRE.—James Watt Memorial Inst., Birmingham. "Modern Developments in Railway Signalling," Major L. H. Peter. 6.15 for 7 p.m.

INST. OF ENGINEERS-IN-CHARGE.—St. Bride Inst., Bride-lane, E.C.4. Social dance.

INST. OF MARINE ENGINEERS: JUNIOR SECTION.—85–88, The Minories, London, E.C.3. Dance. 7.30 to 11.15 p.m.

MONDAY, JAN. 13TH.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN CENTRE.—Armstrong College, Newcastle-upon-Tyne. "A Cathode Ray Oscillograph with High-speed Drum Camera Rotating in Vacuo," Mr. G. A. Whipple. 7 p.m.

INST. OF ELECTRICAL ENGINEERS: WESTERN CENTRE.—Royal Hotel, Cardiff. Annual dinner and dance. 6.30 for 7 p.m.

INST. OF METALS: SCOTTISH LOCAL SECTION.—Joint meeting with Inst. of Automobile Engineers, in Rooms of Inst. of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow, C.2. "Fatigue in Relation to Automobile Engineering," Capt. L. W. Johnson. 7.30 p.m.

TUESDAY, JAN. 14TH.

ILLUMINATING ENGINEERING SOC.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. Mr. F. E. Lamplough will introduce discussion on "Applications of Ultra Violet Light and some Aspects of Fluorescence and Phosphorescence." 6.30 for 7 p.m.

INST. OF AUTOMOBILE ENGINEERS.—At The Geisha Café, Coventry. "The Development Testing of Motor Cars," Mr. C. M. Simpson. 7.45 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Discussion, "Royal Docks Approaches Improvement, London," Mr. Duncan Kennedy and Mr. H. E. Aldington. 6 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Hotel Metropole, Leeds. Problems' Night. 7.15 p.m.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—In the Engineers' Rooms, 39, Elmbank-crescent, Glasgow, C.2. "Private Plants and Public Supply Tariffs," Mr. J. A. Sumner. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: WIRELESS SECTION.—Savoy-place, Victoria Embankment, W.C.2. Sir Noel Ashbridge will open discussion on "Ultra Short Waves for Broadcasting." 6 for 6.30 p.m.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Echo-sounding Equipment for Ships," Captain J. F. Hutchings. 7.30 p.m.

INST. OF MARINE ENGINEERS.—85–88, The Minories, E.C.3. "The Care and Maintenance of a Modern Diesel-engined Tanker Fleet," Mr. H. S. Humphreys. 6 p.m.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—James Watt Memorial Inst., Birmingham. "Light Alloys," Mr. H. G. Warrington. 7 p.m.

INST. OF METALS: N. EAST COAST LOCAL SECTION.—Armstrong College, Newcastle-upon-Tyne. "Hot Pressings in Brass and other Metals," Mr. J. Willis Beard. 7.30 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield. Joint meeting with Junior Inst. of Engineers. "Corrosion in Industrial Atmospheres with Special Reference to Electrical Equipment," Mr. W. Fordham Cooper. 7.30 p.m.

WEDNESDAY, JAN. 15TH.

BELFAST ASSOC. OF ENGINEERS.—Municipal College of Technology, Belfast. "Advertising as a Factor in Marketing the Engineering Product," Mr. J. H. Beaumont Robins. 7 p.m.

INST. OF CHEMICAL ENGINEERS.—In Rooms of Chemical Soc., Burlington House, Piccadilly, W.1. "Flotation as Applied to the Chemical Industry," Mr. W. Cullen and Mr. H. Lavers. 6.30 p.m.

INST. OF PRODUCTION ENGINEERS: PRESTON AND DISTRICT SECTION.—The Harris Institute (Technical School), Corporation-street, Preston. "The Relative Values of White and Black Heart Malleable Castings to Production and Service," Mr. Walter West. 7.30 p.m.

INST. OF STRUCTURAL ENGINEERS: SCOTTISH BRANCH.—129, Bath-street, Glasgow. "Foundations," Mr. S. Smith. 7.15 p.m.

LIVERPOOL ENGINEERING SOC.—9, The Temple, 24, Dale-street, Liverpool. Joint meeting with N.W. Branch, Inst. of Mechanical Engineers. Thomas Lowe Gray Lecture, "The Future of Steam Propulsion," Mr. J. Johnson. 6.30 p.m.

ROYAL MICROSCOPICAL SOC.—B.M.A. House, Tavistock-square, W.C.1. Presidential address by Prof. W. A. F. Balfour-Browne. 5 for 5.30 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. Meeting at 8 p.m.

SOC. OF GLASS TECHNOLOGY: YORKSHIRE SECTION.—Dept. of Glass Technology, Darnall-road, Sheffield. "The Nature of Glass: A Few Suggestions for Further Research," Mr. J. E. Stanworth. 7.30 p.m.

THURSDAY, JAN. 16TH.

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, W.C.2. "Recent Developments in Long-distance Telephony," Mr. A. C. Timmis. 5.30 for 6 p.m.

INST. OF MARINE ENGINEERS.—85–88, The Minories, E.C.3. Junior Section. Debate, "Steam" (Mr. E. Hamilton Gibson, *versus* "Electrical Auxiliaries" (Mr. D. M. Cathcart, 7 p.m.

INST. OF MINING AND METALLURGY.—At Rooms of Geological Soc., Burlington House, Piccadilly, W.1. Discussion: "Notes on the Balimbing Mine, West Coast of Sumatra," Mr. D. W. J. Grey; "Recent Changes Concerning Explosives and their Use," Mr. Wm. Cullen and Mr. J. G. Lambert. 5.30 p.m.

FRIDAY, JAN. 17TH.

INST. OF FUEL.—British Industries House, Marble Arch, W.1. Mr. H. L. Pirie and Mr. Isaac Lubbock will open debate, "Has the Fuel Oil Tax Justified Itself?" 6.30 for 7 p.m.

INST. OF METALS: SHEFFIELD LOCAL SECTION.—The University, St. George's-square, Sheffield. "Gases and Metals," Dr. C. J. Smithells. 7.30 p.m.

MONDAY, JAN. 20TH.

ROYAL AERONAUTICAL SOC.—At Inst. of Electrical Engineers, Savoy-place, W.C.2. "The Theory of Alloy Structures," Prof. W. L. Bragg, F.R.S. 6 p.m. for 6.30 p.m.

TUESDAY, JAN. 21ST.

INST. OF AUTOMOBILE ENGINEERS.—Hotel Metropole, Leeds. "Needle Roller Bearings," Mr. C. H. Smith. 7.15 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. "Road Engineering Problems—Judging the Slippery Road," Dr. R. E. Stradling, Mr. R. G. C. Batson, and Mr. G. Bird. 6 p.m.

INST. OF METALS: SWANSEA LOCAL SECTION.—Y.M.C.A., Swansea. "Modification of Alloys," Dr. A. L. Norbury. 6.30 p.m.

INST. OF STRUCTURAL ENGINEERS: LANCASHIRE AND CHESHIRE BRANCH.—At The Temple, Dale-street, Liverpool. "Welding and Erection of Steel Work for Three-storey Buildings." 7 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. "Embrittlement of Steels," Prof. F. C. Lea. 7.30 p.m.

WEDNESDAY, JAN. 22ND.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Informal discussion, "Replenishment of Underground Water Supply," opener Mr. A. B. Buckley. 6 p.m.

INST. OF CIVIL ENGINEERS: MANCHESTER AND DISTRICT ASSOC.—Visit to works of Metropolitan-Vickers Electrical Company, Ltd., Trafford Park. 2 p.m.

INST. OF FUEL.—At Chemical Soc., Burlington House, Piccadilly, W.1. "The Cleaning of Coal Using Dense Media," Dr. R. A. Mott. 6 p.m.

INST. OF WELDING.—At Manchester School of Technology, Manchester. "Welding as Applied to Steel-framed Buildings," Mr. G. Ramsay Moon. 7.30 p.m.

THURSDAY, JAN. 23RD.

INST. OF CIVIL ENGINEERS: YORKSHIRE ASSOCN.—Hotel Metropole, Leeds. Annual dinner. 6.30 for 7 p.m.

INST. OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, S.W.1. "Foundations of London Structures," Mr. F. S. Snow. 6.30 p.m.

FRIDAY, JAN. 24TH.

INST. OF ELECTRICAL ENGINEERS: LONDON STUDENTS; STUDENTS OF INST. OF CIVIL ENGINEERS AND GRADUATES OF INST. OF MECHANICAL ENGINEERS.—Victoria Halls, Southampton-row, W.C.1. Dance. 8 p.m. to 1 a.m.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN CENTRE.—Grand Assembly Rooms, Barras Bridge, Newcastle-upon-Tyne. Annual dinner and dance. 7 for 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND CENTRE.—Grand Hotel, Harrogate. Annual dance. 8 p.m. to 2 a.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—At Mining Inst., Newcastle-upon-Tyne. "The Protection of Ships' Hulls Against Marine Corrosion," Mr. William E. Lewis. 6 p.m.

SATURDAY, JAN. 25TH.

INST. OF CIVIL ENGINEERS.—Students' afternoon visit to National Physical Laboratory, Teddington.

TUESDAY, JAN. 28TH.

INST. OF AUTOMOBILE ENGINEERS.—James Watt Memorial Inst., Birmingham. "White Metal and Bronze Bearings from the Manufacturer's Point of View," Mr. M. Melhuish; "Needle Roller Bearings," Mr. C. H. Smith. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—North British Station Hotel, Edinburgh. "The Effect of Legislation and Regulations upon Electricity Distribution," Mr. W. Fennell. 7 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. "Colour Photography Applied to Micro-photography," Mr. A. Allison. 7.30 p.m.

THURSDAY, JAN. 30TH.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Joint meeting with Graduates of Inst. of Mechanical Engineers. Hotel Metropole, Leeds. "Variable Speed Transmission." 7.15 p.m.

INST. OF MARINE ENGINEERS.—85–88, The Minories, E.C.3. "The History of Technical Education," Principal J. Paley Yorke. 6 p.m.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—James Watt Memorial Inst., Birmingham. "The Polishing of Metals," Mr. E. J. Dobbs. 7 p.m.

INST. OF STRUCTURAL ENGINEERS: YORKSHIRE BRANCH.—Hotel Metropole, Leeds. "Underpinning and Foundation Work in Loose and Waterlogged Ground by Chemical Consolidation, Ground Water Lowering, and other Means," Mr. H. J. B. Harding. 7 p.m.

LAUNCHES AND TRIAL TRIPS.

MACOMA, single-screw motor tanker; built by Netherland Shipbuilding Company, Ltd., to the order of the Royal Shell Company, The Hague; dimensions, 478ft. by 59ft. 5in. by 34ft.; to carry oil in bulk. Oil Engines; constructed by Messrs. Werkspoor, Amsterdam; launch, December 31st.

VEREIN DEUTSCHER EISENHUTTENLEUTE.—In celebration of its seventy-fifth anniversary, the Verein Deutscher Eisenhüttenleute, Dusseldorf, has issued a handsome historical volume dealing with the rise and development of the Institution and the contemporaneous progress of the iron and steel industry. There are bibliographical references to the number of 646 and a valuable index. A notable feature of the book is the printing at the head of many pages of portraits and brief biographies of men who during the past seventy-five years have influenced scientifically, technically, and commercially the iron and steel industries. The volume is published by the Verlag Stahleisen M.B.H., Dusseldorf, at the price of R.M. 5.

A Seven-Day Journal

A Proposed Scottish Gas Grid.

ON Monday, January 13th, an official inquiry was opened at Lanarkshire House, Glasgow, into the question of the utilisation of coke oven gas in the West of Scotland, and the possibility of forming a Scottish gas grid. The proposed scheme was recommended in February, 1935, by Sir Arthur Rose, Commissioner for the Special Areas of Scotland, and later was approved by the National Gas Council (Scotland). The committee recently appointed by the President of the Board of Trade, after consultation with the Secretary of State for Scotland, has as its Chairman Sir Alexander Walker, who was closely identified with the design and working of the Sheffield gas grid. Other members of the Committee are Mr. T. H. Thorneycroft, Mr. R. Bryce Walker, Mr. J. Jamieson, Mr. P. Dollan, and Mr. G. Evetts, the secretary being Mr. F. J. Coleman, of the Mines Department. The terms of reference empower the Committee to co-ordinate the manufacture and distribution of gas in the West of Scotland and to make recommendations. Evidence was given before the Committee on behalf of the Corporation of Glasgow and the various gas undertakings of Lanarkshire and Renfrewshire, while other evidence was submitted by William Baird and Co., Ltd., William Dixon and Co., Ltd., and James Nimmo and Co., Ltd., along with other firms and undertakings in the West of Scotland, which have surplus quantities of coke oven gas for disposal, or could utilise supplies of gas.

A New Pumping Station at Hertford.

ON Thursday, January 9th, a new water supply works at Aston, Hertfordshire, was opened by the Chairman of the Hertfordshire Rural Water Supplies Committee, Sir Walter Halsey. This is the first of the rural water supply schemes which are to be carried out on lines indicated by the County Council, and which, when completed, will provide water mains to practically every village in the north of Hertfordshire. The water supply at Aston is drawn from two bore-holes sunk in chalk to a depth of 312ft. by deep well centrifugal pumps of 10,000 gallons per hour capacity, driven by 37 h.p. electric motors. The pumping plant was supplied by W. H. Allen, Sons and Co., Ltd., of Bedford; while the boring was undertaken by C. Isler and Co., Ltd., London. Two water towers are provided at Benington and Aston. They are asphalt-lined ferro-concrete structures, the Benington tower having a capacity of 100,000 gallons and a mean head of about 457ft. above Ordnance Datum, the Aston tower having a capacity of 30,000 gallons and a mean head of 380ft. above Ordnance Datum. The feeder mains are 6in. cast iron pipes. The supply mains included in the scheme amount to about 24 miles. The undertaking has cost about £32,500, and was commenced in August, 1934, under the direction of the consulting engineers, Messrs. D. Balfour and Sons, Westminster. The total estimated cost of the county rural water supplies scheme will be about £200,000.

New Bridge over Shadwell Basin.

ON Tuesday last, January 14th, the Ministry of Transport announced that as part of the scheme to improve the approaches to the London docks, it is proposed to build a new bridge in Glamis-road, Stepney, at a cost of £42,700. Mr. Hore-Belisha, Minister of Transport, has now made a grant to the London County Council towards the cost of the scheme and contributions are also being made by the Port of London Authority, which owns the existing bridge, and the Stepney Metropolitan Borough Council. The present swing bridge in Glamis-road over the entrance lock to Shadwell Basin has a carriageway only 8ft. 6in. wide, with two narrow footpaths, and causes considerable delay to traffic to and from the wharves and warehouses in this neighbourhood. The width of the waterway under the bridge is 60ft. It is intended to replace this bridge with a new structure of the bascule type which will have a carriageway of 25ft., and adequate accommodation for pedestrians. The bridge will be operated by electrical machinery of a type that has given satisfaction in other modern bridges and should reduce maintenance difficulties to a minimum. It is hoped to complete the scheme by the end of the present year.

The Institute of Export.

ON Friday afternoon, January 10th, a reception was held at the Cordwainers' Hall, Cannon-street, to mark the establishment of the Institute of Export, a new organisation which will be solely devoted to the development of British export trade and the interests associated with it. The guests, who included representatives of City and industrial undertakings, were received by Sir Francis Goodenough, one of the Vice-Presidents, who, in a short address, explained that the Institute was a development of the British Export Society, which was formed in 1924, and had the active support of our leading industrialists. Membership of the Institute is open to British export executives, including export directors, managers, and others engaged in or in connection with the export of goods manufactured in Great Britain or Northern Ireland, their assistants, and those who intend to take up exporting work as a career, and is divided into four main classes—corporate members, associate members, student members, and students. Membership in all classes is confined to persons of British nationality. The officers of the Institute include: Vice-Presidents, Lord Melchett, Lord Hirst, Lord Meston, Sir Harry McGowan, Major Sir John Prestige, Sir George Beharrell, Sir Harry Brittain, Lieut.-General Sir George MacDonogh, Sir Malcolm Robertson, and Mr. Edward Baron; Chairman of the Council, Mr. R. J. Turner; Vice-Chairman of the Council, Mr. R. Kelso; Secretary, Mr. W. V. Jenkins, and the offices of the Institute are at 21, Tothill-street, S.W.1.

The F.B.I. and Organisation for Defence.

FOLLOWING a recent resolution passed by the Grand Council of the Federation of British Industries, the President has invited to a meeting in the near future all the trade associations which are affiliated to the Federation, with a view to the co-operation of British industry to the full with the Government in any steps that may be found necessary to make good the deficiencies in the defence forces of the Crown. The Associations will be consulted as to the steps they are prepared to take for this purpose with a view to the Government being placed in possession of the proposals of organised industry. The following are amongst the salient points which will be considered at the meeting:—First, the importance of the organised industries of the country being consulted as to the most efficient distribution of orders, either to existing manufacturing plants or to the plants which could be most economically expanded for the purpose; secondly, the question of organised industry coming to an understanding with the Government for the purpose of ensuring that the requirements of the Government should be provided at an economic price, *i.e.*, a price fair to the Government and to industry, which in many cases might have to face large capital commitments to satisfy demands which may not continue, and which are outside ordinary business requirements; thirdly, to ascertain to what extent each industry is prepared to offer its co-operation to the Government, to ascertain how far each industry is organised for this purpose, and if the existing organisation of certain industries is not sufficient to undertake this task, to ascertain whether such industries are prepared to create the necessary organisation for the purpose.

Rainfall in the Thames Valley.

AT a meeting of the Thames Conservancy Board on Monday last, January 13th, Lord Desborough, the Chairman, said that the rainfall in 1935 was the greatest experienced in the Thames catchment area since 1924, and was greater than in 1894, the year of the great flood. The rainfall in 1935 was 33·91in., or 5·66in. above the annual standard average. In 1894 it was 32·44in. During September, October, and November last, 30·96in. of rainfall were recorded as compared with the standard average of 7·94in.; nevertheless, there was still a deficiency of 4·27in. of rainfall since the beginning of the drought in July, 1933. The daily average natural flow of the Thames for 1935 was given as 1465 million gallons, which was only slightly above the standard average 1357 million. The total "run off" was 9·7in., or 28·6 per cent. of the rainfall compared with the standard average of 31·8 per cent. The latter figures supported the possibility that a good deal of water had sunk into the ground and would appear next summer to keep up the tributaries of the Thames. The lowest flow recorded for one day during the year was given as 261 million gallons on August 12th last, and the highest about 6500 million gallons on December 31st, when the river was approaching the peak flow of 9000 million reached on January 3rd. The floods last year were not exceptional; in 1933 the Thames flow measured at Teddington weir reached 9095 million gallons, and Lord Desborough did not think that this year it would be above 9000 million. In 1915 the flow was 11,119 million gallons, and in 1894 it was over 20,000 million gallons.

Dartford-Purfleet Tunnel.

WITH the concurrence of the County Councils of Essex and Kent, it has been decided that the Ministry of Transport will be directly responsible for the construction of the proposed Dartford–Purfleet Tunnel. The preparation of detailed plans is now actively in hand, and it is hoped that it will be possible to invite tenders for the preliminary work at an early date. As now proposed, the length will be more than one mile, exclusive of the open approaches, which will be constructed with a maximum gradient of 1 in 28, and a carriageway of 20ft. with a patrol path on each side protected by a hand rail will be provided. The tunnel will be constructed by means of a shield driven by compressed air through from shafts considerably over 100ft. deep, 900 yards apart, and sited one on each side of the Thames. The top of the tunnel at its lowest point will be approximately 80ft. below Trinity High Water, and the upper part will be in the form of a semi-circle of 30ft. outside diameter, with a flattened invert to support the floor. The tunnel will be of cast iron and concrete segments lined with concrete, the surface of which will be finished with a glazed waterproof material. Ventilation will be furnished by means of fresh air driven through a duct at the top of the tunnel, whence tubes will convey it to orifices placed at intervals along the kerb line, the foul air being extracted from the main tunnel. The tunnel will be available for commercial and public service vehicles, and connecting lines of approach between the tunnel and the arterial roads on either side have been carefully planned by the Ministry. The engineers are Messrs. Coode, Wilson, Mitchell and Vaughan-Lee, and Messrs. Mott, Hay and Anderson, of Westminster.

Our Growing Overseas Trade.

THE Board of Trade returns for December give the figures for the year 1935, and disclose a very satisfactory increase in the volume of trade compared with the totals of the past five years. The exports of all classes of goods amounted in value to £425,921,343, an increase compared with that of 1934 of £29,935,822, whilst the imports were valued at £756,936,175, an increase of £25,522,392. A significant feature of the figures is the proportionately larger increase of exports over imports. The imports and exports of iron and steel considerably increased last year, but trade in the case of these commodities was interfered with by the rise and fall of export duties and the restrictions imposed by the Anglo-Continental steel pact. The totals for the year, however, show a decided improvement upon 1934, the export figures being 2,371,914 tons, valued at £37,093,242, against 2,250,527 tons, valued at £35,092,053, in 1934. It is interesting to note that in spite of the restricted opportunities of accepting overseas orders for pig iron, owing to the necessity of satisfying the strong home demand, the exports for the year amounted to 144,205 tons, the largest total for several years. The quantities of steel defined as general descriptions which were sent abroad also increased, the figures being 208,896 tons compared with 173,280 tons in the previous year. It was only to be expected that as the result of the limitation of imports, the arrivals of foreign steel should show heavy declines. The imports of semi-finished steel, for instance, fell from 330,737 tons in 1934 to 260,920 tons in 1935, whilst the imports of girders, beams, joists, and pillars dropped to 87,243 tons from 100,175 tons. There was an improvement in the exports of machinery, which rose from 335,030 tons in 1934, valued at £32,806,350, to 380,701 tons, valued at £38,495,459. The value of new ships exported, including war vessels, also shows a satisfactory increase from £1,762,495 in 1934 to £3,077,897 last year.

The Naval Conference.

AT the meeting of the Naval Conference, which was held on Wednesday afternoon, January 8th, the various plans for the exchange of information regarding new construction, which had been prepared by the British, French, and Italian delegates, were presented and were received favourably by the United States. The Japanese delegation, however, requested that the Conference should immediately return to a consideration of the Japanese proposition, the first to be discussed, for the acceptance of a common upper limit on naval armaments. It contended that the plans for the exchange of information referred only to qualitative or minor matters, and said it was not willing to discuss minor matters until the important question of quantitative limitation was settled. During the past week several informal meetings between the various delegates took place, which led to a revised agenda for the meeting held on Wednesday afternoon, January 15th, being adopted.

A Coal Trade Consultative Board.

IT was announced on Wednesday, January 15th, that the national organisations interested in the manufacture and distribution of coal-burning appliances have decided to set up a Joint Consultative Board to co-operate with the coal trade. The purpose of the Board is to co-ordinate the efforts made by the coal industry and the makers of heating and cooking appliances burning coal for improved services to the public and greater efficiency in the utilisation of domestic fuel. The new Joint Board was set up by the unanimous decision of a conference at which the following bodies were represented:—British Ironfounders' Association, Builders' and Plumbers' Merchants' Association, Coal-burning Appliance Makers' Association, Coal Merchants' Federation of Great Britain, Coal Utilisation Council, Ironmongers' Federated Association, National Federation of Builders' Merchants. Colonel J. H. M. Greenly has been appointed the first Chairman of the Board, which will be responsible for arranging co-operation between coal merchants, ironmongers, builders' merchants, and manufacturers in different towns, with a view to ensuring that users of solid fuel burning appliances are supplied with the best and most economical fuel. The Board will also consider methods of advising the public regarding modern methods of using coal in up-to-date appliances.

American Beach and Shore Protection Works.

By E. E. R. TRATMAN.

No. I.

IN the vast extent of coast line of the United States—including the Atlantic and Pacific Oceans, the Gulf of Mexico, and the Great Lakes—there are long stretches of sandy shores and beaches, which are becoming an increasingly valuable public asset as population increases and more and more people flock to them and the beach towns for a day's pleasure, a fortnight's vacation, a summer's residence, or a warm winter resort in the semi-tropical southern sections of the country. The beaches are largely public property, although there are many cases where they are in private ownership, at least down to the low-water line. Near the resorts, of course, the property fronting on the beach has a high value, but there are great stretches of coast where the property is wild and undeveloped and far from any towns and settlements.

But beaches and shore front property and the shore line in general are subject to the continual destructive effects of wave, wind, and weather. Persistent currents and ordinary waves may steadily erode the beach, while occasional heavy storms and hurricanes may have disastrous effects. Summer cottages, hotels, large residences, and private and municipal property have been threatened, damaged and even undermined and wrecked by the attacks and encroachments of storm waters. In very many cases, such attacks have demonstrated the absolute inadequacy of local or individual protective works, designed by haphazard methods and with a view mainly to cheapness of construction. Even lighthouses have had to be relocated or abandoned on account of encroachments by the sea.

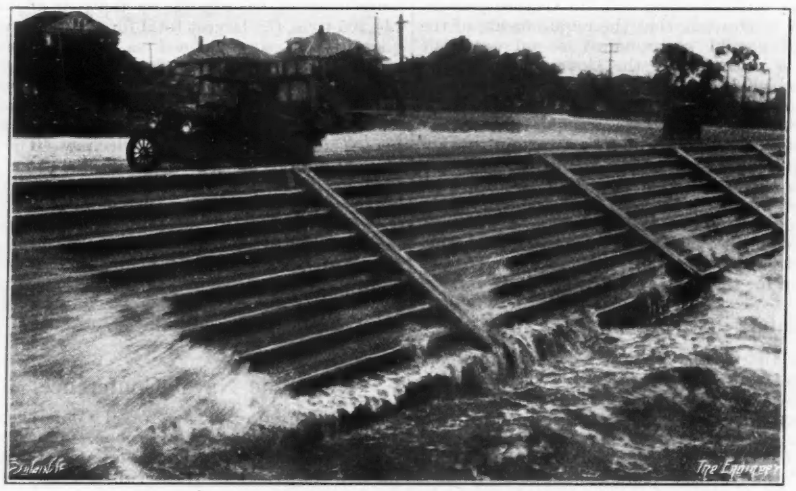


FIG. 1—STEPPED CONCRETE WALL ON GULF COAST

With the development of coastline highways the growth of tourist travel, and of winter migration to the warmer parts of the coast there is a growing—but still inadequate—realisation of the fact that the beaches are valuable public property and a national asset, the protection of which should devolve upon public authority, as in the case of the great mountain parks and the forest preserves.

Protection against erosion by currents and waves and storms is not easily provided, unless handled on a comprehensive scale and by some governmental or public authority. The owners of shore line property can rarely afford to build protective works for their own property or the beach upon which it fronts. And as such protection would be individual rather than co-operative, one piece of protected property may be liable to damage by sea encroachments on adjacent property that has no protection. If adjacent owners would co-operate for the improvement of a definite length of shore front, the work would be much more effective and economical, but it is rarely that this can be managed. Even assistance by constituted public authority is not easy to provide, except perhaps in the case of municipal authorities of coast cities, where the people can readily appreciate the value of the beach as a commercial asset, can also see the ravages of storms and can provide funds adequate for efficient protection.

With larger governmental units, however, inland people usually fail to recognise the gravity of the case, and are not inclined to approve taxation or the appropriation of public funds for protective measures. Even if they visit the beaches, it is usually in the summer and they rarely see the evidences of destructive influences. As a matter of fact, few of the coast States have yet assumed definite responsibility or authority over beach protection. In New Jersey there is a Board of Commerce and Navigation with power to give advisory assistance and to undertake the construction of protective works. In Mississippi the counties are authorised to carry out such protection, and in New York State the city of New York has authority to acquire and protect its beaches.

Education and publicity are developing gradually a greater appreciation of the value of the beaches to the public, and the necessity of preserving them and protecting both the beaches and the adjacent shore lands or property. In many cases storms and hurricanes have given forcible evidence of this necessity of protection, as well as demonstration of the inadequacy of cheap and ill-designed protective works. Progress in the development of public interest is being aided by the American Shore and Beach Protective Association.

In view of the administration difficulties mentioned, the extent of unsettled areas along the coast liable to erosion, and the growing public interest in the general subject of shore—and especially beach—protection, it is of particular interest to note that in 1930 a law was passed by the Federal Government directing the War Department—whose jurisdiction covers all navigable waters—to investigate means of preventing shore erosion. The investigation was made by a Beach Erosion Board, appointed by the Chief of Engineers, United States Army, and including both civil and military engineers. The first report of the Board, issued in 1933, deals mainly with the character and movements of beach sands, the relations between the size of sand particles and the slope of foreshore, and the movement of sand from the ocean bottom to the beach. It includes also special studies as to the effects of beach groynes.

Numerous important and interesting works of various designs have been carried out at different points along the long coast line of the United States, and it is proposed here to describe some of these works for beach and shore protection. No attempt is made to cover in detail the conditions under which the several works were designed, since these vary with practically every beach or location, making each case a problem in itself.

These influencing or governing conditions and factors may include the geographical position; exposure; prevailing winds and wave directions; storm characteristics; deep or shallow water; tidal range; fine or coarse sand particles; flat or steep slope of beach; offshore bars and shoals or barrier beaches; littoral currents affecting the movements of sand along the shore; whether the water breaks on the beach in the form of waves or rollers; the angle of waves to the shore line; tributary population; and the formation of the land or property behind the beach. Other factors may occur at individual locations. The opinions and experience of the engineers, the character and value of the shore line property, and the costs of alternative methods of protection, will also enter into the problems. Beach slopes have been given as approximately 1 vertical on 25 horizontal to 1 in 150 with fine sand, 1 in 10 for coarse sand, and as steep as 1 in 4 with gravel. A flat beach of fine sand has usually a hard surface.

Protective works are of two general types: first, sea walls along the shore line to stop the waves and definitely prevent encroachment beyond that line; second, groynes at approximately right angles to the shore line and extending across the beach into deep water, to break the force of diagonal waves and to prevent erosion of the beach by littoral currents, while checking the velocity of waves and currents in such a way as to cause the sand in suspension to be deposited and thus build up the beach. Sheet piling is an essential feature in many designs of both sea walls and groynes. When concrete sheet piles are used they are generally designed by the engineers of the individual works and are also made locally. Steel sheet piles, however, are commercial rolled shapes on the market, different forms or sections being produced by different steel concerns.

Sea walls may be divided into three classes: first,

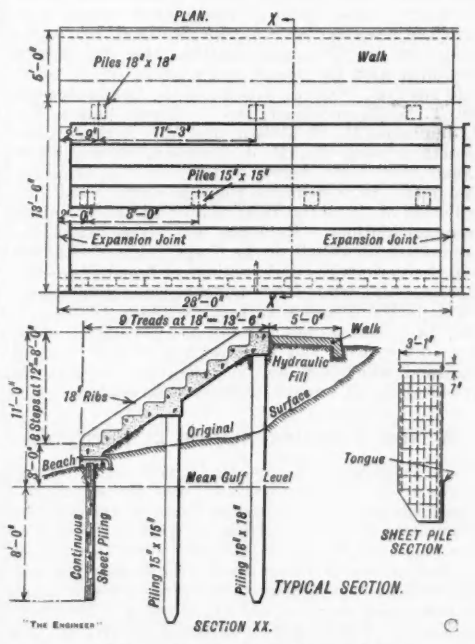


FIG. 2—DESIGN OF GULF COAST WALL

paved and stepped inclined surfaces, on which the waves may lose their force and energy; second, massive vertical walls of concrete designed to resist wave impact; third, thin vertical walls of sheet piling or concrete, well anchored and braced, and sometimes reinforced by heavy rubble rock deposited along the face of the wall. Those of the first class may be considered as walls, being usually supported on piles as foundations, although in some cases they are simply revetments, supported only by the ground upon which they rest. Those of the third class are often termed "bulkheads." In many cases their function is to act mainly as retaining walls for the property at the rear of the beach, so that they are rarely subjected to direct wave action in the way of

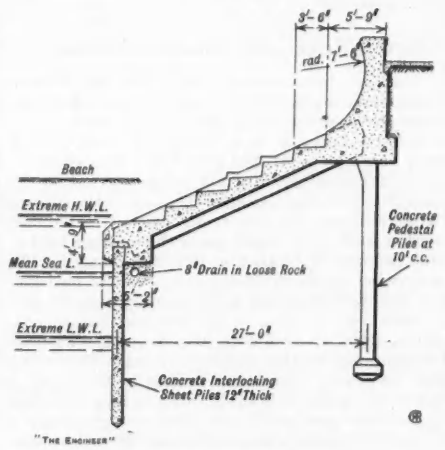


FIG. 3—SEA WALL AT SAN FRANCISCO

impact or undermining. However, in other cases they are distinctly sea walls. There are, of course, works which cannot be included in the above classification and which must be grouped in a "Miscellaneous" class.

STEPPED SEA WALLS.

The longest concrete sea wall in the world, and probably the longest modern sea wall of any design, is of the stepped type which has been used at several points around the United States coast. In this type the wall consists of an inclined concrete slab supported on piling and having its upper surface formed in a series of steps for the purpose of breaking up the waves as they strike the wall. These sea walls differ materially in design and details, and their

slope or inclination ranges from 1 vertical on 1½ horizontal to 1 on 4½.

GULF COAST SEA WALL.

The exceptionally long sea wall mentioned above extends for 25 miles along the South Coast of the State of Mississippi, where the fine beach, a scenic motor highway along the shore and valuable road and water front property are subject to attack every few years by tropical storms and hurricanes from the Gulf of Mexico and the West Indies. Along this part of the coast the tidal range is only about 2ft., or 4ft. in equinoctial storms. This sea wall is said to be the longest in the world, with the exception of the ancient Hangchow wall in China—180 miles. That wall also is of the stepped form, but built of large squared granite blocks.

Various protective works had been built along the Gulf Coast at different times by municipalities and landowners, but such piecemeal methods were of little avail in preventing the periodical encroachment of the sea. Individual property values were not sufficient to warrant the cost of effective protection by owners, and there was no authority for providing such protection as a public work. An examlpe of the situation was a sea wall built for the city of Bay Saint Louis in 1914, which consisted of concrete interlocking sheet piles 20ft. long and standing 8ft. high above the beach. About 6ft. in the rear of every fifth pile a concrete anchor pile, 12in. square and 6ft. long, was driven with its top flush with the beach. A 1in. rod projecting from this anchor was hooked into the sheet pile about 2ft. below its top. Through hooked rods projecting from the tops of the piles a longitudinal rod was threaded as reinforcement for a concrete coping poured in place and having its sea face sloping outward as a wave break. Sand was pumped in behind this wall.

In 1915 this work, with others of similar light construction along the Gulf Coast, was destroyed by a hurricane. Heavy seas swept over the wall and washed out the sand behind the sheet piling, and the combined impact and erosion then wrecked the structure entirely.

As a result of the enormous damage done along several miles of this part of the coast by the great storm of 1915, the State of Mississippi passed a law for the appointment of a commission to study the subject and authorising the counties concerned to issue bonds for the construction of a sea wall. Delay on account of the World War led to the enactment of a revised law in 1924. Then Harrison County, with 27 miles of frontage on the Gulf, undertook to carry out such a project. About 15 miles of the sea wall was built in 1925 and 10 miles more in 1927. A view of this wall is given in Fig. 1.

This long sea wall, designed by Mr. Hobart D. Shaw, and shown in Fig. 2, is a stepped concrete slab supported on two rows, square concrete piles, and a line of concrete sheet piling at the toe. The slab, with steps of 18in. tread, is formed as a beam at the toe, at the top and under the middle step. Under the top of the slab the piles are 18in. square and 18ft. long; they are spaced 11ft. 3in. on centres, or 5ft. 6in. at the expansion joints, which are 28ft. apart. In the middle row the piles are 15in. square, spaced 8ft. apart, or 5ft. at the joints between the slabs. The sheet piles are 10ft. long, extending 8ft. below mean sea level. They are 37in. wide and 7in. thick. Their vertical reinforcing rods projected above the top, so as to be embedded in the beam along the toe of the slab.

It is to be noted that the tongue-and-groove joints of the piles exist for only the bottom third of the length of the piles, instead of for the full length, as in some other designs. This tongue-and-groove arrangement was intended only to guide the piles while being driven. The upper part of the joint would then be left in the form of a small round hole, to be filled with grout by means of a miniature tremie, and thus make a solid core, completely sealing the joint. This plan worked successfully in the main, but in a few places the workmen were careless and did not complete the grouting properly. This defect resulted in some leakage of the sand filling behind the wall and thus caused trouble. However, the defect is considered as one of construction and not of design.

The division of the wall into lengths of 28ft. was adopted for economic reasons, the expanded metal used for reinforcement being manufactured in 7ft. lengths. At the ends of each 28ft. section, the steps are interrupted by a beam or rib 18in. deep and 9in. wide, having an inclination of 1 on 1½. The ½in. expansion joints between adjacent beams are of the interlocking or tongue-and-groove type. In the joint a prepared expanding material or filler was placed before the concrete of the adjacent slab was poured. Weep holes of 2in. cast iron pipe, extending through the toe, are of a bent shape in order to prevent the escape of the fine sand of the backfilling. The slope of the wall is 1 on 1¼, which is slightly less than the angle of repose of the backfilling. Behind the top of the wall is a concrete walk 5ft. wide, but separated from the concrete sea wall by an open joint.

After several years of service the wall was found on recent inspection to be essentially intact. Two weak points disclosed by experience are the joint between the sea wall and the walk, and the joints between the sheet piles, as ineffective grouting of the sheet pile joints—noted above—allowed escape of the sand filling, so that in several places the walk has dropped. It has been suggested that for a future wall of this kind the top walk should be of greater width and formed integrally with the stepped slab, while the sheet piling should be made about 15ft. deep, with special precautions to secure tight joints.

To restore the walk to position, the sunken slab was jacked up and sand was pumped under it. This work was done by a gang of three men with a 3in. petrol-driven centrifugal pump on a portable wheeled frame or carriage. One man handled the suction hose to keep it in the loose sand; another directed the discharge hose, and the third watched and moved the machine. The most difficult part of the repair work was to find the defective joints in the sheeting where sand was escaping. When such a joint was found, a wooden box form was driven down in front of it, and concrete poured in to seal the joint.

In construction, the sheet piles and bearing piles were put down by water jets and then by a steam pile hammer suspended from the jib of a crawler crane travelling on the beach. Each joint of the sheeting was grouted as soon as a pile was driven. A drag-line excavator built the bank or dike to the proper slope, with a 5ft. berm at the top. Then the slope was dressed by a template to serve as the back of the form, after which the steel forms were placed in 28ft. lengths. A concrete mixer was mounted on a platform car on a railway track behind the wall, and the concrete was placed either by a bucket or a belt conveyor, being well rammed in place and finished to a smooth surface with floats.

The backfilling behind the wall and dike was then placed by hydraulic dredges, which also pumped quantities of sand to raise adjacent low ground to the level of the top of the wall. These dredges were required to work at least 1000ft. from shore, in order to avoid disturbing the beach or forming hollows along the shore. After the settlement of the backfilling, the reinforced concrete walk was built. Drains and watercourses were carried through the embankment and sea wall by box culverts or pipes, leading from catch basins on the land side.

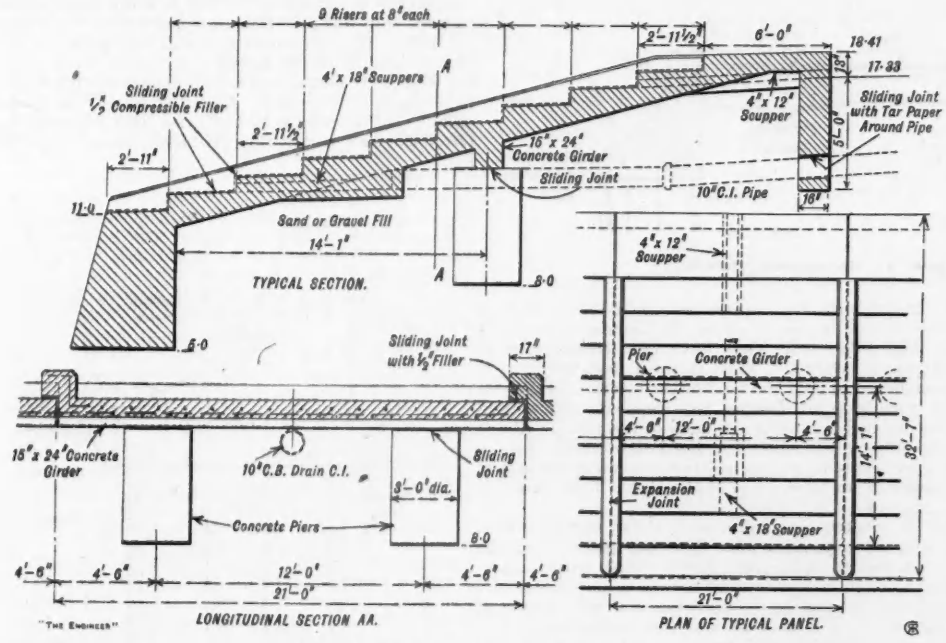


FIG. 4—SEA WALL AT REVERE BEACH

San Francisco Beach Sea Wall.

Besides extended protective work on the California State highway along the Pacific Coast—to be described—many of the towns and cities along that coast have had to provide protection of some kind to prevent destructive erosion of the beaches, and sometimes of public or private property along the ocean front. In 1915 Mr. Ralph Bennet, consulting engineer, proposed an inclined wall of concrete, with a slope of about 1 on 2, supported on timber piles and forming a smooth slab extending far enough below the beach line to prevent scour, and having at its shore end a vertical extension or deflector with a curved concrete face. A beach protection wall at San Francisco is one of many of this general type, but with the surface of the slab formed in steps. This was designed by a former city engineer, the late Mr. M. O'Shaughnessy.

The city of San Francisco is situated on a narrow peninsula. Its commercial water front is on the east or bay side. On the north is the Golden Gate channel, while parks and a long stretch of sand beach lie along the west or ocean front. The sand here has a depth of some 200ft. The Ocean Beach Boulevard, parallelling the shore, at the back of the beach, is about 20ft. above mean sea level of the Pacific and 16ft above extreme high tide, but in heavy storms the waves would sweep up the embankment and across the road. In places the sea had encroached about 70ft. There is a tidal range of about 12ft.

To protect the boulevard, a concrete sea wall has been built for a considerable distance. This wall (Fig. 3) is of the inclined stepped type, having a slope of approximately 1 on 2·21, with steps of 19in. rise and 42in. tread. To prevent scouring action by waves running along the wall, the steps are interrupted at intervals of 20ft. by beams of H section, the slabs fitting against the webs of the beams. At the upper end of the slab is a vertical extension or wall, 8ft. high, rising 3ft. 6in. above the boulevard level to form a parapet. This vertical part of the sea wall has a concave face of 7ft. 6in. radius, curving outward at the top as a throw-back and ending with a 12in. coping curve.

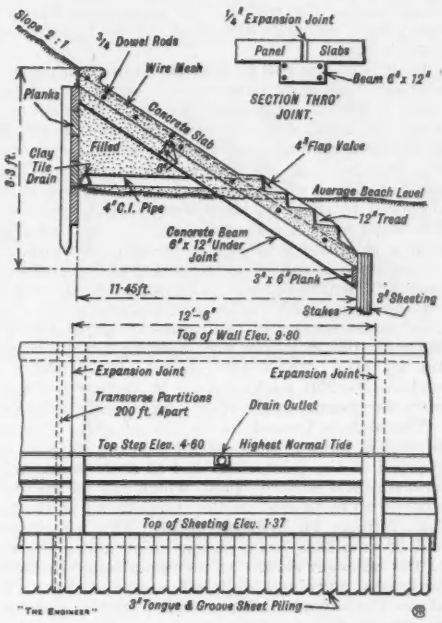


FIG. 5—SEA WALL ON CHESAPEAKE BAY

At its toe, the sea wall is supported on a line of concrete interlocking sheet piles, 12in. thick driven about 16ft. into the sand. At its rear or land end is a line of 24in. concrete pedestal piles enlarged at the bottom, spaced 10ft. on centres. Between the pedestal piles, steel sheet piling is driven. These sheet piles are of unusual design, each having embedded in each end, the head of an interlocking steel pile. At one end is the ball head and at the other end the socket head. In this way the continuous interlocking of the joints from top to bottom is assured. The ends of the piles are recessed or grooved along the steel heads, these grooves between adjacent piles being grouted with cement.

In the stepped slab, the minimum thickness is 12in. At the beams, 20ft. apart, the thickness is 3ft. 7in., the beams extending 17in. below the slab to serve as anchors in the filling. Longitudinal beams are formed at the toe and at the top, in which the pile heads are embedded. Under the beam at the toe and behind the sheeting is a longitudinal 8in. drain laid in a bed of loose stone.

At intervals of 150ft. the broad steps are interrupted by stairways down the face of the slab, leading from

openings in the parapet wall. The total vertical height of the wall is about 25ft., but the top is only about 15ft. above the normal beach level along the wall. The sand filling under the sea wall is covered with a blanket of clay, 18in. thick, to prevent the sand from escaping through cracks or crevices. Cross walls of sheet piling were also driven under the slab, at intervals of 150ft., to limit damage or failure in case of undermining of the wall. Behind the parapet is a 20ft. walk, then a 15ft. parking space for automobiles, and then the roadway, 150ft. to 200ft. wide, with a 20ft. walk on the further side.

The first part of this sea wall was built some years ago. There has been no scouring, but rather a tendency for the accumulation of sand along the foot of the wall.

As proof of the necessity of substantial construction in works of this kind, it may be noted that a wall of somewhat similar design at Longport, on the Atlantic coast, was partly destroyed by a storm in 1919. In this case, however, wood sheeting was used under the toe of the wall, and owing to defective joints the backwash of the waves sucked out the sand filling until the wall collapsed under the impact of the waves and the rush of water behind it.

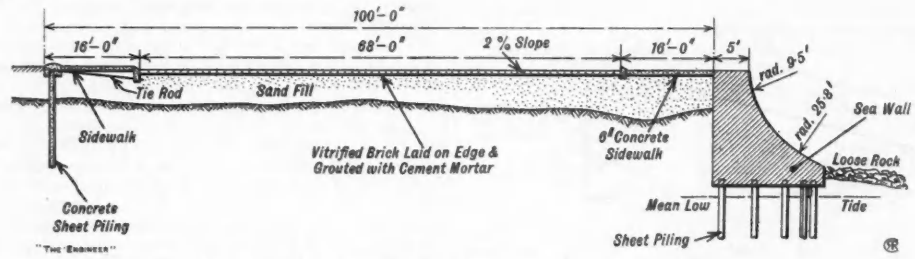


FIG. 6—SHORE PROTECTION WORK AT GALVESTON, TEXAS

SEA WALL AT REVERE BEACH.

A stepped sea wall, 1500ft. long, which has only shallow supports instead of deep piling, has been in service for some years at Revere Beach, on the north-east coast. This is notable for its flat slope of approximately 1 on 4½. It was built by the Parks Department of the Metropolitan District Commission of Massachusetts. Although not exposed directly to the ocean waves, the wall has to sustain the blows of heavy seas, owing to the width of the bay opposite the beach.

From Fig. 4 it will be seen that besides a deep toe wall and back wall, both formed integrally with the stepped slab, the slab is supported at the middle by a row of 36in. concrete cylinder piers about 6ft. deep, and spaced alternately 9ft. and 12ft. on centres. The underside of the slab is formed with a beam 15in. by 24in., which is seated on the cylinders and anchored to them by short vertical rods or dowels. The steps have a rise of 8in. and a tread of 35½in. Sand and gravel is filled closely under the slab.

Two lines of drains are provided at the middle of each 21ft. length of wall. The upper one is simply a surface drain, with concrete scupper, 4in. deep and 12in. wide, formed in the concrete. Below this is a drain of 10in. cast iron pipe opening into a scupper, 4in. by 18in. These 10in. drains extend under the wall and the 20ft. parking space in the rear to connect with catchbasins in the road which parallels the wall.

The slab is formed in lengths of 21ft. with ½in. expansion joints. But instead of being tongued and grooved at the joints, one end of each slab is made with a raised curb or beam, which has its underside stepped so as to seat on the stepped end of the next slab, forming an L-shaped joint. Thus the stepped end of each slab has a sliding joint under the curb of the adjacent slab. At its upper end, the slab is horizontal, forming a walk, 8ft. wide and about a foot above the adjacent area provided for the parking of automobiles.

At each end of the sea wall the slab is formed with an end wall or cut-off, 9ft. deep, to prevent the escape or scour of the sand filling.

CHESAPEAKE BAY SEA WALL.

A combination of a plain and stepped surface in a sea wall, to break the sweep of the waves, is on Chesapeake Bay, near Cambridge, Maryland, for the protection of the sea front of a private estate. Much money had been spent in building and repairing a timber bulkhead or wall, while groynes of timber and loose rock had been laid across the beach at irregular intervals. But the bulkhead had been persistently undermined, and the groynes had not prevented scouring of the foreshore. As erosion threatened the grounds and a large residence, some more effective, but economical, protection had to be devised for nearly a mile of exposed water front. The tidal range is about 3ft.

In this case the work was a revetment rather than a wall, since no supporting piles were used. As shown in Fig. 5, it consists essentially of a slab of reinforced concrete, having a slope of 1 on 2. Above the old bulkhead the ground had been dressed to that slope and faced with turf. This turfed and landscaped slope was left intact, ending at about 9ft. above low tide. Below its toe the ground was held temporarily by a vertical wall of short piles and planking. The beach surface along this wall was a little above maximum high tide level.

At about 12ft. out from this timber wall, a line of 3in. tongued-and-grooved wood sheet piling was driven to a clay stratum, the piles being 3ft. long with their tops about a foot below low tide. Precast reinforced concrete beams, 12in. wide and 6in. deep, were then placed, with an inclination of 1 on 2. Their lower ends were seated against a plank waling piece behind the sheeting, and their heads rested against the plank bulkhead. Clay was deposited under and between the beams and dressed to a slope level with their top surfaces.

Upon the sloping surface were cast the deck slabs, 6in. thick, reinforced with wire netting and steel rods. They are in lengths of 12½ft. with ½in. calked joints over the beams. Dowel rods connected the slabs across these joints. For drainage a 4in. clay drain pipe was laid longitudinally on the filling, at the level of maximum high tide. Connected to this, at intervals of 200ft., were 4in. cast iron drains leading through the face of the slab, the weep holes being filled with flap valves to prevent the sea water from entering.

In order to break up the waves, the lower part of the slab is formed in steps, the highest of which is at high-tide level. They have 12in. treads, pitched slightly seaward. This stepped construction is also found to hold the sand of the beach. As is usual in such stepped designs, the steps are interrupted by inclined beams at the ends of the slabs. Above the steps is the smooth inclined slab, which ends in an overhanging coping to stop any wave wash that may run up to the top of the slab. This coping is 12in. wide.

In construction, alternate slabs were poured. Then the expansion joint filler was placed, and the intermediate slabs were poured. With gravel aggregate a rich concrete mixture was used. To ensure effective resistance to abrasion and the action of salt water, the concrete was thoroughly tamped or rammed and finished to a smooth, hard surface. Special care was taken with the finishing of that part of the slab lying between high and low-water lines. Forms for the slabs were attached to wires projecting from the precast beams.

In eight years of service there has not been any break or settlement, according to special report. The only defect is a little surface disintegration in some slabs that were built during freezing weather, and were exposed to salt spray before the concrete had set. But construction had to be continued under these circumstances in order to complete the protective work before the winter storms. A fine wide beach has now built up or accumulated over the entire length of the wall, and in many places the sand is now higher than the top step on the slabs. This work was planned and carried out by Mr. Howard W. Underwood, with Mr. L. T. Emory as consulting engineer.

GRAVITY SEA WALLS.

The more conventional type of sea wall, in the form of a massive retaining wall backed by a solid filling, has been adopted in a number of cases. Most of these heavy structures have a concave face designed to reduce the impact of the waves and to throw back the wave crest and spray in order to prevent any large volume of water from over-topping the wall. In places of minor exposure, relatively small concrete gravity walls in precast sections have been used successfully. The sections are made at a gravel pit or local concreting plant as near the site as practicable. They are then conveyed on motor trucks and set in place on the prepared foundation at the beach by means of a jib and tackle or a light crane. These minor structures are usually to serve principally as retaining walls for property fronting on the beach, and are therefore beyond ordinary high-water line, as a rule.

GALVESTON SEA WALL.

Probably the best known and most noted of all American shore protection works is the great concrete sea wall at Galveston, Texas, the first section of which was built in 1903, after the city had been almost destroyed in 1900 by one of the periodical hurricanes from the Gulf of Mexico. This original stretch of 3½ miles was extended later, and again in 1919, so that it now extends 7 miles from a jetty protecting the harbour entrance westward to the city boundary.

The city of Galveston is at the eastern end of an island, paralleling the mainland, but separated from it by a channel. Originally the land was little above ordinary high-tide level, so that many parts were flooded by exceptional tides. Hurricane storms, which occur every few years, have sometimes almost submerged the island. The storm of 1900 reached the highest level on record, and the damage by waves and currents was aggravated by the wrecking of buildings in a wind reaching a velocity of 100 miles an hour. While the surface elevations of the ground were 4ft. to 9ft. above mean sea level, the water reached elevations of 10ft. to 15ft., or 6ft. higher than any former record. A board of engineers decided that adequate protection could be given by a sea wall 3½ miles long, having its top 17ft. above mean sea level, and then filling in the land behind it to an elevation of 10ft. to 12ft., sufficient to provide for drainage and sewerage systems. At 200ft. from the wall this filling was to be at elevation 18ft., with a surface slope in both directions. It is to be noted that the wall is not the only protection, as it is supplemented in front by heavy rock rip-rap at the toe, and in rear by a paved backfilling which slopes up from the top of the wall to receive water driven over by gales or hurricanes.

This work has been entirely successful. Even the old work built in 1903 is reported as showing no damage or deterioration, except in a few scars where a large ship was driven against the wall in the storm of 1915. In that storm the wall was pounded for forty-eight hours by heavy seas driven by a wind of 60 to 100 miles an hour, with masses of solid water sweeping over the wall. After that storm the backfilling was increased in width to 200ft., sloping up from the wall to elevation 21ft. above mean sea level.

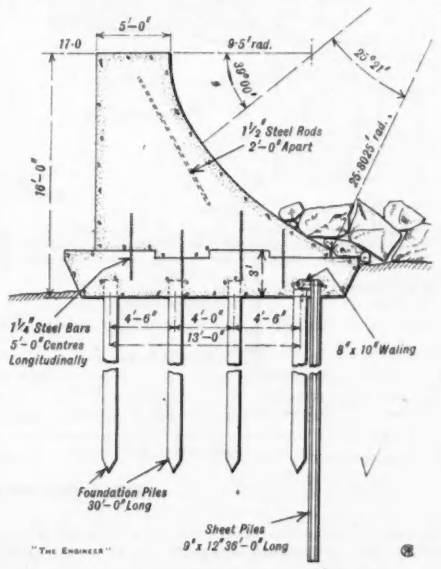


FIG. 7—GALVESTON SEA WALL

To prevent erosion of this fill by waves that overtop the wall, a curtain wall of concrete sheet piling 14ft. deep was driven at 100ft. from the sea wall, and the area between the curtain wall and sea wall was paved with brick laid on edge in cement mortar.

As to the sea wall design, shown in Fig. 6, the foundation is of timber piles about 35ft. long and spaced 4ft. on centres, with a line of wooden sheet piling 24ft. or 36ft. deep under the toes of the wall. Each pile is made of three planks, 3in. by 12in., spiked together to make a tongue-and-groove joint. None of the timber was treated. In some of the later extensions, however, concrete sheet piling has been used. Rock work or rip-rap forms an apron about 35ft. wide and 4ft. thick, composed of quarry blocks from 6 or 8 tons weight down to "one-man" size. The wall is 16ft. wide and 16ft. high, 5ft. wide on top, and with a vertical face 4ft. high at the toe. For the concave face, the radius is 9ft. 6in. for 39 deg. from the top, where it serves to throw back the waves. Below this the radius is 25ft. 9in., running into the toe.

In the more recent construction, Fig. 7, as carried out by the Engineer Corps of the United States Army, a concrete footing course, 3ft. thick, was built on the foundation piles, the top having longitudinal grooves or recesses to bond with the concrete of the wall proper and so prevent sliding. This footing course was 18ft. wide on the bottom and 22ft. on the top, giving a projection of 2ft. on each side of the wall in order to carry the steel forms.

Level with the top of the wall is a 16ft. concrete walk, having a transverse slope of 1 in 50 for drainage. Adjacent to this is the filled ground with a top width of 100ft., including a paved width of 68ft. and with a 16ft. walk on the inner or land side. Along the outer edge of this walk is the curtain wall of concrete sheet piling. Outside this again the fill continues for another 100ft. width and then slopes to normal ground level, except where the whole surface has been filled to the new elevation for business or industrial districts. The concrete curb on the roadway side of the inner 16ft. walk serves as an anchorage for the top of the sheet piling, to which it is connected by tie rods. A rounded curb on the other side of the walk forms a beam which encloses the top of the sheet piling.

(To be continued.)

Pretoria's Electricity Undertaking.

A STRIKING illustration of the way in which the development of the industries of South Africa has caused the increase of the production of electricity is afforded by the progress made by the electricity undertaking of the City of Pretoria—once the capital of the Transvaal Republic, and now the administrative capital of the Union of South Africa. Fifty years ago Pretoria was merely the centre of an agricultural district; to-day, it has a considerable number of industries, at least two of which are of great importance, namely, the railway workshops and the works of the South African Iron and Steel Industrial Corporation. The demands of the latter have been the greatest factor in the expansion of the electricity undertaking.

HISTORICAL.

Pretoria was the first town in the Transvaal to be lighted by electricity. A concession was granted by the Republican Government in 1889 and was taken over by the Pretoria Lighting Company in 1890. The first plant was commissioned in 1892, and comprised five 40-kW, 120-volt Crompton direct-current generators, belt driven by Paxman horizontal non-condensing engines, which received their steam supply from locomotive type boilers. This plant was replaced in 1902 by high-speed direct-driven condensing sets generating at a pressure of 500 volts, while water-tube boilers were substituted for the existing ones. The municipality purchased the concession in 1904, and remodelled the station. Then, with the introduction of electric trams in 1910, further additions to the generating plant were necessitated. The load grew steadily, though slowly, and in 1919 it became necessary once more to consider extensions to the plant. It was at once evident that a new position would have to be sought, as the Schoeman-street site did not offer adequate fuel storage and cooling water facilities for a much enlarged plant; moreover, no rail transport was available or could be made available to this site. At this time the maximum load was 2700 kW, and as the plant was fully loaded, no new consumers could be connected.

NEW POWER STATION ERECTED.

The site selected lies approximately 3 miles west of the centre of the city. It is in the industrial area, and is sufficiently removed from the residential parts not to be a nuisance. Rail facilities existed and an excellent position for a dam was at hand, and one was constructed with a total capacity of 90 million gallons. The original plant installed comprised three 3000-kW Fraser and Chalmers G.E.C. turbo-alternators, generating three-phase, 50-cycle alternating current at a pressure of 6600 volts. The steam-raising plant consisted of six Babcock and Wilcox boilers, each having a normal evaporative capacity of 18,000 lb. per hour, and a maximum capacity of 24,000 lb. per hour. The working pressure was 350 lb. per square inch, with a final temperature of 650 deg. Fah. The main 6600-volt switchgear was supplied by the British General Electric Company, and consisted of cellular type gear having a rupturing capacity of 150,000 kVA. Similar switchgear was installed at the Schoeman-street converting sub-station.

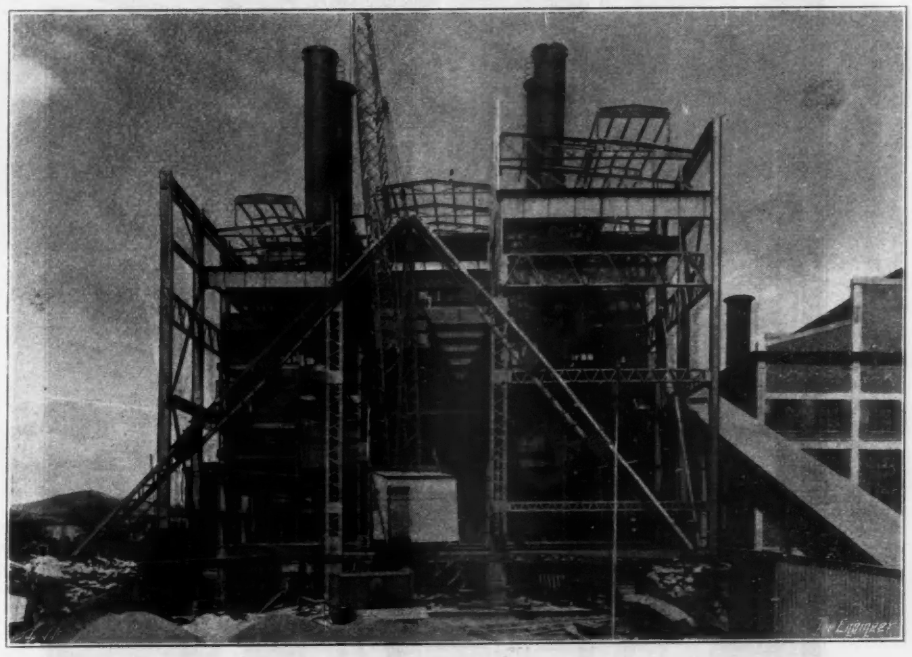
The new plant took over the whole of the load early in March, 1924, and in the four months up to the end of June the maximum load rose from 2700 kW to 4200 kW. This increase was due to the fact that for some time prior to the commissioning of the new station, it had been necessary to refuse all applications for new connections, and therefore when the Council was in a position to give new supplies, the department was kept exceedingly busy connecting up these new consumers. Since the trams necessitated the retention of a direct-current supply, five 750-kW Bruce Peebles motor converters, 6600–500 V, were installed on the site of the old D.C. generating station at Schoeman-street.

As already mentioned, it was anticipated that the 9000 kW of plant installed at the power station at Pretoria West would adequately meet the demand for some fifteen years, but by the winter of 1927 the maximum load sustained for an hour had already exceeded the safe normal capacity of the installed generating plant. Thus in a little more than three years from the date of commissioning the original plant, an extension became necessary.

1927 EXTENSIONS.

It was decided therefore to enlarge the plant by the addition of one 7500 turbo-alternator and one boiler having a normal evaporative capacity of 40,000 lb. per hour, and a maximum capacity of 60,000 lb. per hour. The set installed comprised a Belliss and Morcom turbine and General Electric Company alternator generating three-phase alternating current at a pressure of 6600 volts. The boiler plant was installed by Babcock and Wilcox. The installation of the additional plant required extensions to the buildings, and the turbine house addition was made large enough to accommodate a further generating set, while the boiler house extension was designed to accommodate two boilers. The new plant was commissioned early in 1931.

Before the 1927 extensions programme had been completed, the growth in load had necessitated consideration of further additions to the plant. At this stage the Council had already completed preliminary negotiations with the South African Iron and Steel Industrial Corporation, whereby the latter would take a supplementary supply of electrical energy from the Council's system, and although no specific information in regard to the steel work's requirements was available, a maximum of 6000 kW to 8000 kW was considered to be likely. Up to then all generation had been effected at 6600 volts, while this voltage also formed the primary transmission voltage. A transmission voltage of 11,000 volts was, however, already in use for the supply to a stone quarry situated some 10 miles north of Pretoria, and having regard to the rapidly increasing demand for electrical energy and the expansion of Pretoria in a direction away from the power station, it was considered advisable in the interests of economy and security of supply to adopt 11,000 volts as the normal primary transmission pressure for the future. The question then arose as to whether all new generating plant should be designed for a generating pressure of 12,000 volts, or generation at 6600 volts be continued with step-up transformers to attain the higher voltage. Having regard to the factors, the former course gained the decision, and the new generator was accordingly designed to generate at the pressure of 12,000 volts.



ERECTION OF BOILER-HOUSE AND BOILERS—DECEMBER, 1934

1930 EXTENSIONS.

The turbo-alternator installed is of C. A. Parsons single-cylinder pure reaction type, driving a three-phase alternator at 3000 r.p.m. It is designed for an economical output of 12,500 kW and a maximum output of 15,625 kW. The steam conditions are 350 lb. per square inch (gauge) stop valve pressure, with superheat to a total temperature of 650 deg. Fah. Arrangements are made to extract steam from the turbine at a pressure of about 6 lb. absolute to heat the feed water to a temperature of 150 deg. Fah. in a single stage. Prior to being circulated through the feed heater, the feed water is used as a cooling agent for the steam used in the jets of the steam jet operated air ejector.

The alternator is of the totally enclosed "turbo" type, and is designed for 15,625 kVA, 12,000 volts at 0·8 power factor and 50 cycles, at a speed of 3000 r.p.m., and is capable of carrying a 25 per cent. overload for two hours. To maintain a continuous supply of clean, cool air to the alternator, the closed circuit system of forced ventilation, using a surface type air cooler, is employed. The air is circulated by means of a motor-driven fan mounted inside the foundation block. The surface condenser is of the Parsons "Inverted" type. It has a cooling surface of 18,500 square feet and requires 17,900 gallons per minute of cooling water at 80 deg. Fah.

Since with the installation of this new turbo-alternator, generation would be carried out at both 6600 volts and 12,000 volts, arrangements had to be made for transferring electrical energy from one set of bus-bars to the other. Two coupling transformers by Metropolitan-Vickers were therefore installed between the 6600 and 12,000-volt switchgear. Each transformer comprises a three-phase core type unit having a normal full load rating of 4000 kVA, with its windings connected star/star, and with a tertiary delta winding. The neutrals on both sides are brought out and can be earthed through the 6600 and 12,000-volt neutral earthing gear when occasion demands, such as when one set of bars are being supplied through the transformers only. The transformers are provided with on-load tap-changing gear which is remote controlled from the main 12,000-volt control board, individual or parallel control being possible. The usual position indicators and signalling lamps are provided. In addition to these visual indications, audible indication of a tap change is provided by a Klaxon horn on the control panel. The tappings are arranged on the 12,000-volt windings, each phase being split into two parts with the tappings arranged on one side of the break. Seven tapping points are provided, covering a range of $\pm 7\frac{1}{2}$ per cent., and the connections are taken from these points to a terminal board, and thence to the tapping switch through an opening in the wall between the transformer and tap switch tank. A centre-tapped reactor is used to maintain the current during a tap-changing operation.

Since the 6600-volt switchboard has a rupturing capacity of only 150,000 kVA, the coupling transformers are designed to have an inherent reactance of 10 per cent. thus avoiding any necessity of installing separate reactors between the two sets of bus-bars. The 12,000-volt switchboard, which was supplied by A. Reyrolle and Co., Ltd., has a rupturing capacity of 500,000 kVA, and comprises 800 ampères and 1200 ampères horizontal draw-out type A 2 metal-clad gear. Duplicate bus-bars are provided and bus-bar selection is by removable plugs. Indication of the position of these plugs is given by a single turret indicator mounted above the centre hood of the circuit breaker and by means of a semaphore indicator on the control panel. The circuit breakers are of the solenoid operated type. The only other major item of plant installed during these extensions comprises a second Babcock and Wilcox boiler, having a normal capacity of 40,000 lb. of steam per hour. This unit is an exact replica of the boiler installed under the previous extensions. The plant comprised in these extensions was placed in commission in January, 1933.

THE 1933 EXTENSIONS.

Still the demand on the station was increasing rapidly, and it became apparent early in 1933 that no time should be lost in proceeding with a further extension of both generating and steam-raising plant in order to meet the ordinary growth in load and the additional requirements of the steelworks. After due consideration of all the factors, including the cooling water limitations and the future growth of the undertaking, it was considered that the lay-out for the new plant should be suitable for a station which would have an ultimate capacity of 50,000 kW. In order to provide for this the turbine room has been extended to take a new 12,500-kW set—installed last October—and permits of the addition of a further 12,500-kW or 20,000-kW set at a future date. Should additional plant then be required, the present 3000-kW sets would be removed, and an additional 20,000-kW or larger set could be installed in their place. The boiler house has likewise been extended to accommodate four boilers, each having a maximum continuous rating of 100,000 lb. per hour. Two such

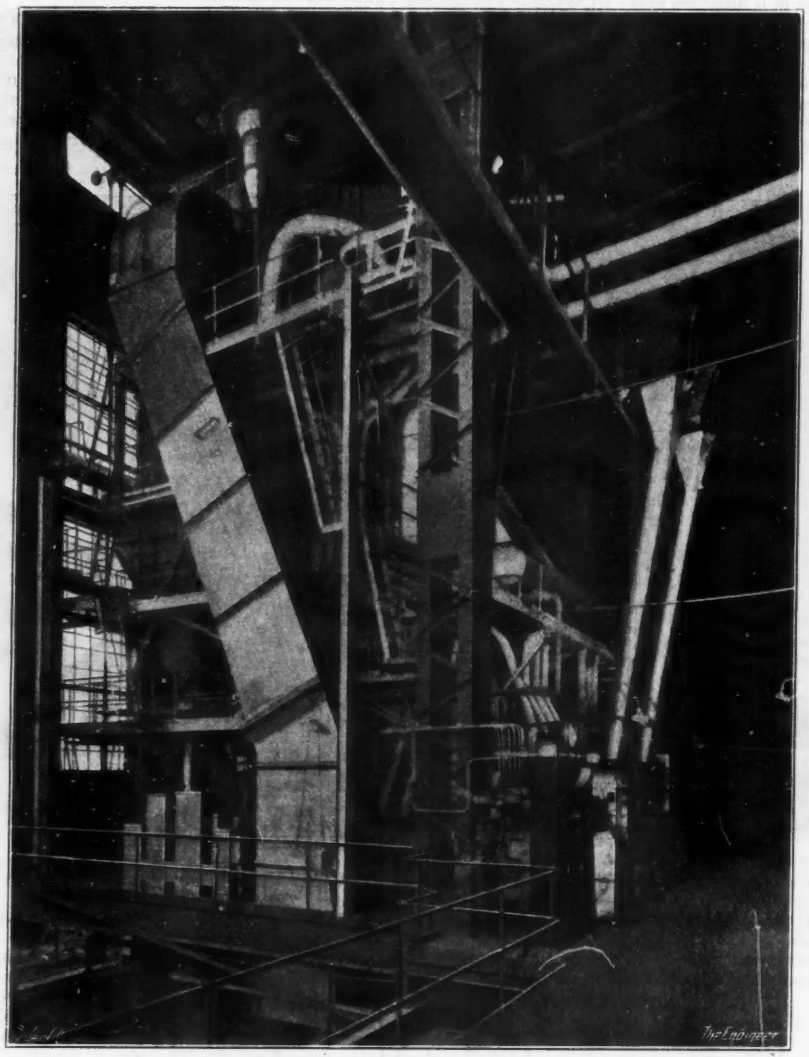
boilers have already been installed under these 1933 extensions, while a third is on order.

The crane originally provided for the turbine room was of the hand-operated type, having a capacity of 20 tons, and in view of the larger machines now being installed, a 50-ton electrically operated crane, manufactured by Herbert Morris, Ltd., has been provided. The 1933 extensions include also extensive alterations to the cooling water tanks and the provision of improved coal-handling facilities. The main features of these, together with those of the plant which has been added, are as follows :—

Two boilers of Yarrow and Co.'s manufacture have been installed, while a third, exactly similar in design, has been ordered and will be in commission early in 1937. Each of these boilers is designed for a normal evaporation of 80,000 lb. per hour and a maximum continuous evaporation of 100,000 lb. per hour. The working pressure is 365 lb. per square inch, the designed pressure being 430 lb. per square inch, with a final steam temperature at normal load of 675 deg. Fah. The guaranteed efficiency on normal load is 87·75 per cent. Each boiler has five drums—a saturated steam drum, 57in. diameter ; a large water drum, 30in. diameter ; and two smaller water drums and a superheater drum, each 23in. diameter. The generating surface comprises 1¾in. diameter tubes, arranged in three banks. The economiser is of the Foster type. Each boiler is fitted with an air heater of the Yarrow type, comprising 1283 2¾in. diameter vertical tubes, each 10ft. long. The gases pass upwards through the tubes, while the forced draught fan draws air from the upper part of the boiler house, the air making a double pass of the air heater before entering the hot air ducts leading to the large dust hopper below the stoker. Bailey water walls form the lower part of the combustion chamber on all four sides, the ignition arch being of the "archless" setting and the rear arch of the usual flat type. A mechanical stoker of the Babcock and Wilcox forced draught compartment chain grate type is fitted to each boiler. The driving mechanism is arranged to give eight speeds and each stoker is fitted with a Lea coal meter.

The mechanical draught plant for each boiler comprises individual forced and induced draught and secondary air, motor-driven, fans, manufactured by Davidson and Co. The forced and induced draught fan motors are of the two-speed type, but the fans are so designed that variable-speed hydraulic couplings may be fitted at a later date. A primary dust collector connected to a "D" type secondary collector is fitted on the suction inlet of the induced draught fan. The secondary air fan draws its air from the hot air duct and discharges it through a series of nozzles in the front arch of the boiler.

Each boiler is equipped with a self-supporting steel chimney having a dust collector at the base. The boilers are equipped with ash hoppers discharging the ash into cocopans or railway trucks. Two high-pressure pumping units recirculate the sluicing water. The dust-handling equipment is incorporated with the ash-handling equipment. Each boiler is provided with three dust tanks, each having a capacity of 53 cubic feet. Two outer tanks collect the dust from the secondary grit collectors and the centre tank collects the dust from the chimney base and the back pass of the boiler. The dust from the hopper below the superheater is passed directly into the ash hopper. Each of the dust tanks is connected by chases to the sluiceway and combined hydrovac ejector and feed valves are used to discharge the dust from the tanks into the sluiceway. The two 40/60,000 lb. per hour boilers installed under previous extensions are also being fitted with this system of ash handling. The boilers are fitted with Cope's feed-water regulators. To assist the water circulation in the boiler when starting up, each boiler is provided on each side with a water circulator. The water drums are interconnected and a small injector supplied with steam from the range induces the cold water from the bottom of the drums to circulate to the steam drum.



VIEW IN THE BOILER-HOUSE

THE NEW TURBO-ALTERNATOR.

The turbo-alternator installed last October was supplied by the British Thomson-Houston Company, and has an economical rating of 12,500 kW and a maximum continuous rating of 15,625 kW. The turbine is of the single-cylinder impulse type, designed for a stop valve steam pressure of 350 lb. per square inch, with a temperature of 650 deg. Fah. The first stage comprises a Curtis wheel on which the automatic nozzle control governing takes place. The turbine is arranged for extracting steam at two points, one for the evaporator and the other for the feed-water heating when the evaporator is out of commission. Steam for the evaporator is extracted at a pressure of approximately 41 lb. per square inch absolute, while the steam extracted for feed heating has a pressure of 6·9 lb. per square inch absolute. This latter pressure corresponds to the vapour pressure in the second effect of the evaporator. With steam from either the second effect evaporator or bled from the turbine, or a combination of both, the feed water is heated to 150 deg. Fah., with the plant running at the economical output.

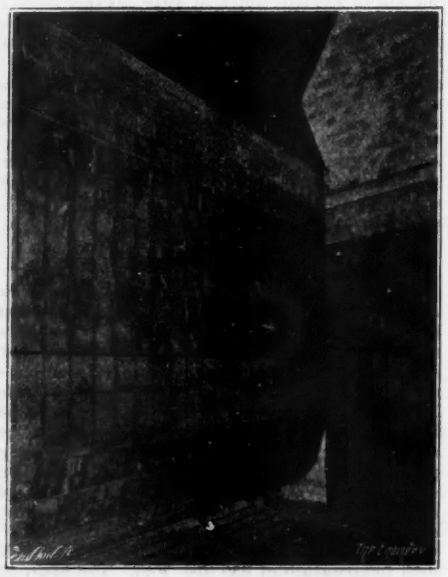
The alternator is designed for a continuous maximum output of 15,625 kW at 0·8 power factor lagging, and in accordance with the present policy generates at a pressure of 12,000 volts. The alternator is self-ventilating, fans being mounted on the retaining rings at each end of the rotor. A closed system of ventilation is employed. The exciter is of the British Thomson-Houston stabilised type, and consists of a standard type exciter with which is mounted in the same frame a small auxiliary machine running at constant voltage with a saturated magnetic circuit.

The condensing and evaporating plant was manufactured by the Mirrlees Watson Company. The condenser is of the normal type, and has a cooling surface of 21,000 square feet. When supplied with 16,000 gallons per minute of cooling water at an inlet temperature of 80 deg. Fah., it is capable of condensing 126,300 lb. of steam per hour and of maintaining an absolute back pressure of 2in. Hg. The evaporator is of the double-effect coil type, and is capable of producing 8550 lb. of make-up per hour. The vapour from the first effect passes to the coils of the second effect, and then drains through the crude water heater, thus giving up its heat to the evaporator feed.

Two 1200-kVA, 12,000/525-volt, three-phase, 50-cycle transformers have been installed by the British Thomson-Houston Company for the supply to station auxiliaries.

WATER-SOFTENING PLANT.

Make-up water for the boiler feed is drawn from the town mains. This water contains calcium and magnesium carbonates in about equal proportions, giving a total hardness of about 13 deg., there being very little permanent hardness. In order to remove the scale-forming constituents, the water is distilled in evaporators, but trouble was experienced owing to the presence of carbon dioxide in the condensed evaporator water. To counteract the effect of the carbon dioxide, it was the practice for some years to add lime to the hot well, and in an endeavour to keep the sulphate carbonate ratio correct for the prevention of caustic embrittlement, sodium sulphate was also added to the hot well. As was inevitable, in the course of time the lime and sodium sulphate interacted to give calcium sulphate, and this was deposited as a hard scale in the bottom tubes of the boiler, leading to the blistering of several of the tubes. It was therefore decided to install water-softening plant ahead of the evaporators, but pending its being commissioned it was decided to suspend the previous lime-soda hot well treatment, and substitute for it the addition of tri-sodium phosphate to the hot well. Besides acting as a preventative against corrosion and caustic embrittlement, the phosphate gradually removed the scale which had formed in the boiler tubes.



BAILEY WALLS OF BOILER COMBUSTION CHAMBER

The water softener installed is the Kennicott type K, and is capable of treating 2000 gallons of water per hour. Although the nature of the water called for lime treatment only in order to eliminate the trouble from carbon dioxide, provision is made for soda ash treatment as well, in case the water should change its nature or be taken from some other source. Actually, soda treatment has been necessary, owing to the slight trace of permanent hardness. After treatment in the softener the water passes into the evaporators, and thence to the feed system. Small additions to the tri-sodium phosphate are made to the hot well as a preventative against corrosion and caustic embrittlement.

Prior to the commissioning of the new water-softening plant, it had been necessary to de-scale

the evaporator coils at fortnightly intervals, and the scale formed was of such a hard nature that it had to be chipped off, thus entailing a risk of damaging the coils. Since the new plant has been in operation, however, it has been found that monthly scaling of the coils is sufficient, and even then the scale formed is usually so soft that it can be brushed off with ease. Practically no scale is found in the boiler tubes, and what little there is, is of the same soft nature, and requires only brushing for its removal.

CIRCULATING WATER.

Up to the time of the present extensions the cooling water requirements of the station had been served by a 3ft. 6in. diameter low-level intake and a high-level intake. The former was installed at the outset for the supply to the three 3000-kW sets, while the latter served the 7500-kW and first 12,500-kW sets. The internal ducts were interconnected by means of a 2ft. valve. Since the addition of another set required provision to be made for increased cooling water facilities, the opportunity was taken of providing a new intake works capable of supplying requirements up to the estimated ultimate capacity of the station. These works comprise a low-level intake consisting of an 8ft. by 7ft. duct in the situation formerly occupied by the 8ft. 6in. diameter intake. This duct delivers into a fine screening chamber from which an 8ft. by 7ft. duct leads to the valve chamber of the former high-level intake, and then continues as a 7ft. by 5ft. duct to a new valve chamber, which serves the duct supplying the new 12,500-kW and future machine. The old internal duct supplying the three small machines has been connected in at the fine screening chamber and the 2ft. valve has been replaced by a 4ft. valve.

COAL-HANDLING FACILITIES.

With the rapid growth of the load, the coal-handling facilities had become totally inadequate. A coal storage bunker of 3000 tons capacity has therefore been constructed. This is of reinforced concrete construction and is situated below ground level. Coal is discharged into the bunker direct from the railway hoppers, and is delivered through valves on to a 24in. cross conveyor belt running below the bunkers. This in turn delivers the coal on to the inclined conveyors which elevate it to the top of the boiler house whence it is conveyed by cross conveyors and scraper conveyors to the coal hoppers supplying the boilers. Practically all manual handling has thus been eliminated, and the arrangements are now more in keeping with the station as it exists to-day.

CONCLUSION.

As will appear from the particulars given in this description of the progress of the undertaking, extensions to the Pretoria power station have been in almost continuous progress since 1930, and the difficulties attending operation during this period have been such as to prevent the best being got out of the plant, but provision now appears to have been made to meet the demand for some years to come, and no doubt the results will show the benefit of the more stable conditions. The capital expenditure, including distribution system and everything so far, is about £1,500,000, of which £700,000 has been invested in the power station since 1922, giving a cost per kilowatt of approximately £17. The extension just completed, and bringing the total kilowatts installed up to 41,500, has cost about £310,000. The City Council, early in 1935, increased the maximum amount to be lent by the Council to owners of property for the installation of electrical appliances from £75 to £100, and this, it is anticipated, will greatly stimulate the installation of such appliances, and consequently the consumption of electricity.

Mr. L. L. Horrell, City Electrical Engineer to the City of Pretoria, who has been responsible for the designing and carrying out of the scheme of extensions, and has been warmly congratulated upon the skill and ability displayed in bringing it to a successful conclusion, very kindly furnished the data, &c., required to describe the progress of the undertaking and the various stages in its expansion up to the present.

Various views of the plant are given on these pages and on page 76.

THE case of the freight train getting out of control when descending Miles Platting incline, on the approach to the east end of Victoria Station, Manchester, on January 1st, was inquired into, on behalf of the Ministry of Transport, by Major G. R. S. Wilson, on the 8th. The main question appears to be whether the train, in accordance with the rule, stopped at the top of the incline to have some of the wagon brakes pinned down, and, if not, why not. In answering that question there is the fact that the evidence showed that, despite the rule, practically only heavy trains of, say, forty loaded wagons of coal stopped. The signalman at Victoria East Junction, at the foot of the "bank," was faced with the problem of having to turn the runaway train into one or other of two lines, on each of which was a loaded passenger train. He chose that on which the train would be less heavily laden, to which the locomotive was not attached and which had the longer overrun after the impending collision. For this action the signalman was commended by Major Wilson.

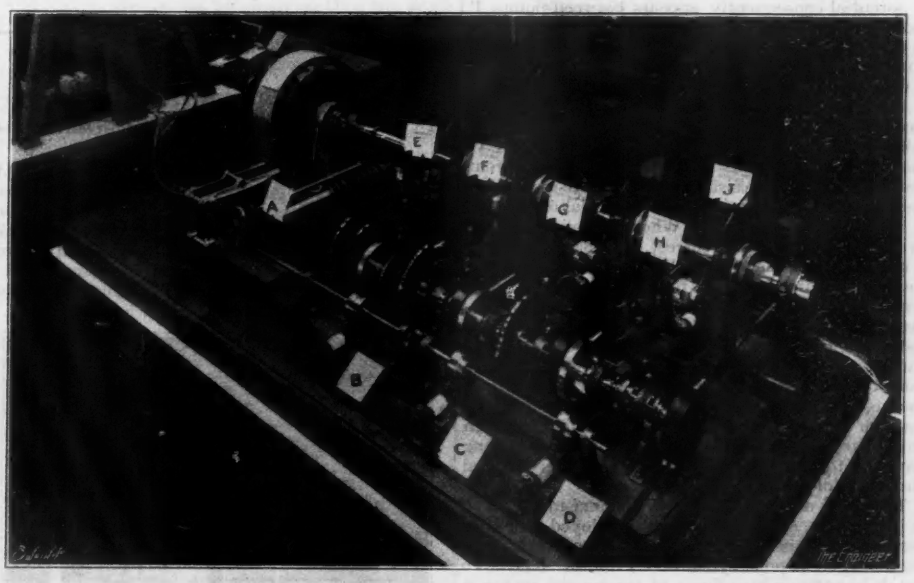
The Physical Society's Exhibition.

No. II.

(Continued from page 44, January 10th.)

A SPEAKING clock, which announces the time over the ordinary telephone at intervals of 10 sec. with an accuracy of 0·1 sec., was one of the principal exhibits of the Post Office research station. Announcements taking the form such as "At the third stroke it will be eleven, seventeen, and forty seconds," are followed by three "pip" signals at one second intervals and of one-tenth second duration. Four glass discs—see Fig. 14—carrying concentric circular sound tracks photographically recorded serve for making the announcement. One disc rotating at 60 r.p.m. carries the odd numbers 1 to 59, and another the even numbers 2 to 58. Each disc has associated with it an optical system with a photo-cell, which is automatically centred over the appropriate track by means of a cam mechanism, brought into operation by the opening once every 10 sec. of a shutter electro-magnetically controlled, *viâ* a cam switch. In this way each minute of the hour is spoken at the correct instant. The hour is given by a similar photo-electric system and disc rotating at 30 r.p.m., and carrying the phrases "it will be one," &c. The first portion of the preliminary phrase "at the third stroke" is reproduced by means of a fixed optical system from a track recorded on the fourth disc, which also carries the record for the final part of the phrase. This disc also rotates at 30 r.p.m. The discs, cam mechanism for moving the reproducing system, and the cam switches for opening the shutters in the correct sequence are driven at constant speed by means of an eight-pole, three-phase synchronous motor supplied with 4-cycle current and running at 60 r.p.m. Operating power is obtained from a high power amplifier following a Van der Pol three-phase oscillator.

To ensure that the error between the last pip and true time may not exceed 0·1 sec., the clock mechanism is hourly synchronised to Greenwich time. To maintain the required accuracy at intermediate times the speed of the mechanism must be kept constant at least within one part in 36,000. These conditions are met by means of a free pendulum. Mounted at the bottom of the seconds-beating pendulum A—Fig. 15—is a photographic transparency B, shown enlarged at C. By means of a lens system an image of the vertical narrow illuminated slit D is focused centrally on the transparency when the latter is at rest. The shape of the transparent areas is such that when the amplitude of swing of the pendulum is equal to exactly half the length of the base line of the transparency, the amount of light passing through the trace and falling on the photo-cell E varies sinusoidally with a frequency of 4 cycles per second. The photo-cell feeds into a two-stage amplifier F, the output from which, under correct conditions of pendulum swing, is a sine wave such as that shown at G. If the amplitude of swing is too small, the wave form obtained is similar to H, whereas if the amplitude



A.—Cam-operated Selector Switch Controlling Sequence of Opening Shutters.
B.—"Minutes" Change Cam Mechanism.
C.—"Hours" Change Cam Mechanism.
D.—"Seconds" Change Cam Mechanism.
E.—Odd "Minutes" Optical System.
F.—Even "Minutes" Optical System.
G.—"It will be....." (Hours) Optical System.
H.—"And.....Seconds" Optical System.
J.—"At the Third Stroke" Optical System.

FIG. 14—SPEAKING CLOCK

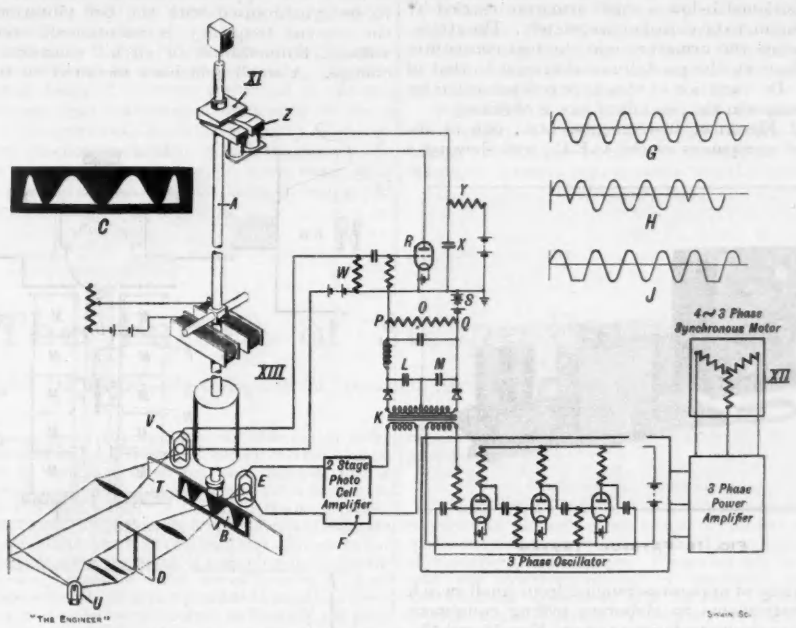


FIG. 15—CONTROL SYSTEM FOR SPEAKING CLOCK

of swing is too great, the shape shown at J is produced.

This wave form distortion produced by alteration in the pendulum amplitude is used to control the driving force applied to the pendulum. The output from the amplifier F is applied to a transformer K, one secondary winding of which has a centre tap. By means of rectifiers the condensers L and M receive charges due respectively to the positive and negative half cycles of the current. The difference in potential between the two condensers is applied after smoothing to the resistance O. When the amplitude of swing of the pendulum is correct and the wave form symmetrical as at G, the charges on the condensers are equal, and there is no p.d. between points P and Q. The potential of P relative to the earth line, *i.e.*, the effective bias applied to the grid of the gas-filled relays R is then simply that due to the battery S. As the amplitude of swing falls the wave form becomes unsymmetrical as at H, and the charges on the condensers become unequal. A difference of potential consequently appears between points P and Q of such sign that the effective negative bias on the gas-filled relay is reduced. This change of bias is utilised to permit application of a driving impulse to the pendulum.

At the mid point in each left-to-right swing of the pendulum a shutter T allows a narrow beam of light from a source U to fall on the photo-cell V. An increase then occurs in the photo-electric current flowing through the resistance W, with the result that there is a momentary rise in the potential of the grid of the gas-filled relay R. When the amplitude of swing of the pendulum is correct, this rise in potential is insufficient to make the relay conducting. When, however, the amplitude has fallen by a predetermined permissible amount, the reduction in effective steady bias produced by the p.d. appearing across the resistance O is such that the relay becomes conducting at the instant of application of the impulse from the photo-cell V. The condenser X, which is charged through a high resistance Y, then discharges through the energising coils of the magnet Z, which on attracting the armature XI applies a driving impulse to the pendulum and restores normal amplitude of swing.

The main shaft of the clock mechanism is driven at 60 r.p.m. At the frequency employed—4 cycles per second—this speed is obtained by a direct drive from an eight-pole synchronous motor XII. To obtain maximum steadiness of torque the motor is designed as a three-phase separately excited machine. The operating power—about 30 watts—is obtained from the high power amplifier following the three-phase oscillator with its frequency maintained constant at 4 cycles per second by injecting into one of the grid circuits a small 4 cycles e.m.f. from the tertiary winding on the output transformer K of the photo-cell amplifier F.

The speed of the clock mechanism is thereby positively controlled by the pendulum and a high degree of constancy secured. The clock is checked hourly by a signal transmitted from Greenwich. Should this not arrive when the clock mechanism is in the exact position corresponding to the hour, one of a number of relays (depending on the magnitude and sign of the error) is operated. The operation of the relay causes the current in the coil of the magnet XIII, positioned below a small armature carried by the pendulum, to be varied appropriately. The attraction between the armature and the coil constitutes a small force on the pendulum, additional to that of gravity. By variation of this force compensation for slight changes in the pendulum rate is obtained.

Salford Electrical Instruments, Ltd., one of the associated companies of the G.E.C., was showing a

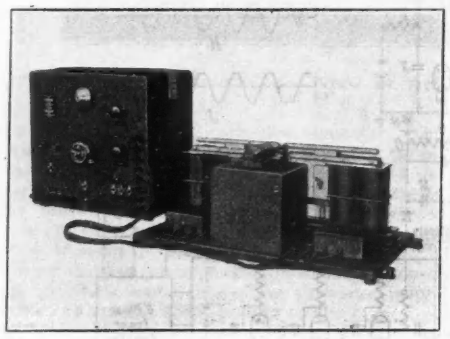


FIG. 16—FATIGUE TESTER

wide variety of apparatus ranging from small switchboard instruments to elaborate testing equipment. The electro-magnetic fatigue tester—Figs. 16 and 17—is an improved form of the model exhibited last year. The bar to be tested is vibrated electro-magnetically at its natural frequency, so that it resonates, and a complete test is made in a few hours. By measuring the bar deflection at an antinode, the actual stress applied can be calculated by using the modulus of elasticity which can be determined from the bar frequency. A recorder gives the number of cycles applied before failure takes place, and on the occurrence of a crack in the specimen, the apparatus is automatically put out of action. With the aid of several vibrating units more than one bar can be vibrated at the same time, and by varying the stress of each, different times of failure are made to occur and are indicated on the chart of the single recorder.

The complete equipment consists of the vibrator unit, a power supply unit, and a "logtime" recorder, or, alternatively, an hour meter. The power supply unit operates from A.C. mains and supplies D.C. to the vibrator unit for polarising the magnets, and A.C. of adjustable frequency for superimposing an A.C. field, the frequency being adjusted manually so that it corresponds with the mechanical natural frequency of the bar, which then resonates with a relatively large amplitude. By its vibration the bar

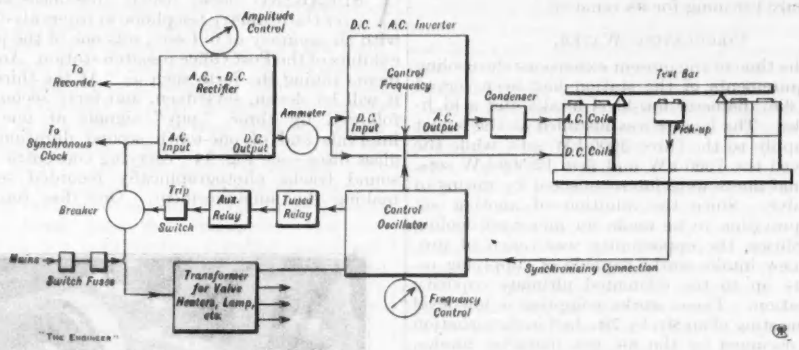


FIG. 17—SCHEMATIC DIAGRAM OF FATIGUE TESTER

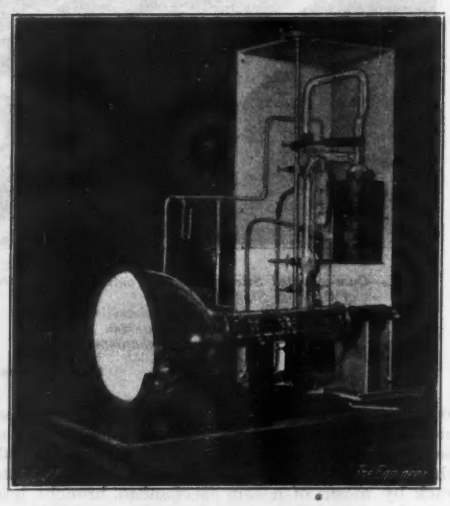


FIG. 18—DEMOUNTABLE CATHODE-RAY TUBE

generates a small voltage in a pick-up coil beneath it. This voltage is fed back to the control circuit of the power supply unit and causes the A.C. output to be synchronised with the bar vibration. Thus the current frequency is maintained, even if the voltage, temperature, or circuit constants slightly change. A small gold bead mounted on the bar is observed in a microscope, and the image of the bead drawn into a line by the vibration is measured by a scale in the eyepiece and gives a direct measure of the amplitude of vibration. Output of the power supply unit is adjustable. The amplitude of vibration can therefore be adjusted to give the desired value of stress in the bar. A tuned relay, which can be set to operate at any required frequency, serves to trip the apparatus on a crack occurring. Normally, it is set to operate at about 5 cycles lower than the natural frequency of the bar. When a crack begins to form in the specimen the natural frequency drops and the tuned relay comes into operation and trips the circuit breaker. A dial on the relay calibrated in cycles per second can be used for measuring the rod's natural frequency as well as for setting the relay. When the power unit shuts down, the corresponding pen on the recorder stops writing, thus indicating when the bar has failed. The time of operation or the number of cycles endured varies over wide limits. For steel bars the range may be taken as 10^4 to 10^8 cycles.

One of the most attractive exhibits of the G.E.C. laboratories was the demountable cathode-ray tube—Fig. 18—developed primarily to facilitate the design of high-vacuum cathode-ray tubes for television. A special 12in. diameter cathode-ray bulb is provided with a vacuum-tight ground glass joint at the end of the neck. The detachable portion of the joint carries a twelve-pin cap for making connection to the twelve contacts on the electron optical bench inside the tube. The effect of different arrangements of electrodes on spot sizes, brightness and distortion, on sensitivity to control, &c., can readily be determined. The tube operates satisfactorily at 4400 volts, and the time required to open, make an adjustment, and pump out again is usually less than thirty minutes. After several exposures to the atmosphere the cathode retains its emission.

Much might be said about the G.E.C. research exhibits, which related, among other things, to the after-glow effects of fluorescent materials under cathode-ray bombardment, discharge tubes coated with luminescent powders, a thermionic voltmeter for very high frequencies, a capacity-type variable attenuator, an accurate frequency standard for checking low-frequency quartz crystals, and a stiffness meter.

Improved apparatus for measuring the pull between magnetised surfaces was exhibited by Professor MacGregor-Morris and Mr. C. R. Stoner. The main features of the apparatus are shown in Fig. 19, which is almost self-explanatory. It is an improved form of an apparatus demonstrated before the Physical Society in October, 1934,* and the experimental results given below were obtained by Mr.

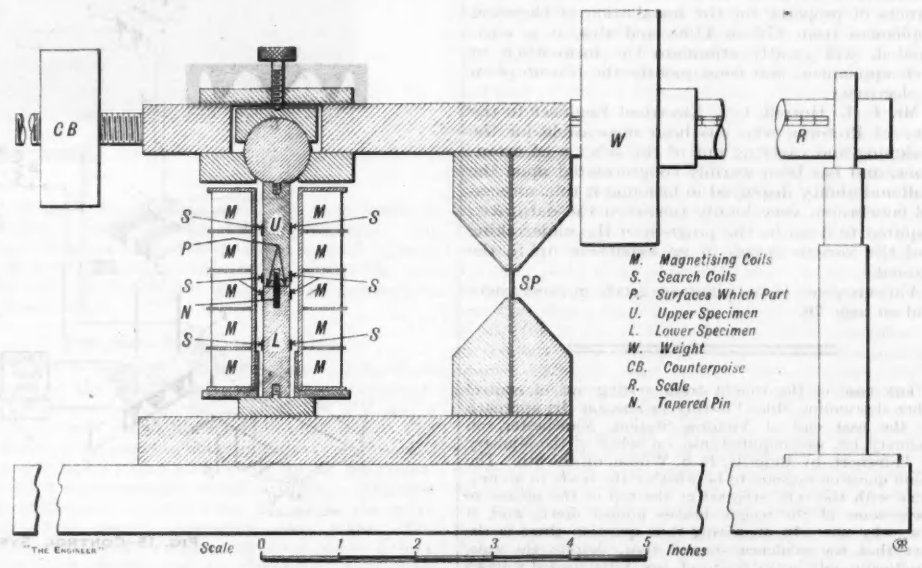


FIG. 19—SECTION THROUGH MAGNETIC PULL APPARATUS

A. G. Gale Thomas working in conjunction with Prof. MacGregor-Morris. The specimen under test is a cylindrical rod 1 cm. diameter and 3½in. in

* "A Simple Apparatus for Measuring the Pull Between Two Magnetised Surfaces," MacGregor-Morris and Stoner, "Proc.," Phy. Soc., Vol. 47, p. 186, 1935.

length. It is cut in two and the opposing faces are carefully surfaced.

It will be noticed that search coils are wound on the upper and lower halves of the specimen under test. The ampère turns provided by the currents in the five magnetising coils are adjusted so as to make the flux uniform throughout the specimen.

A study of previous forms of apparatus devised with the object of determining the relation between magnetic pull and flux density shows that the chief causes of error are due to two sources: (1) uncertain magnetic joints, and (2) tilting of surfaces on parting. The first source of error has been reduced in the present apparatus to an absolute minimum by the

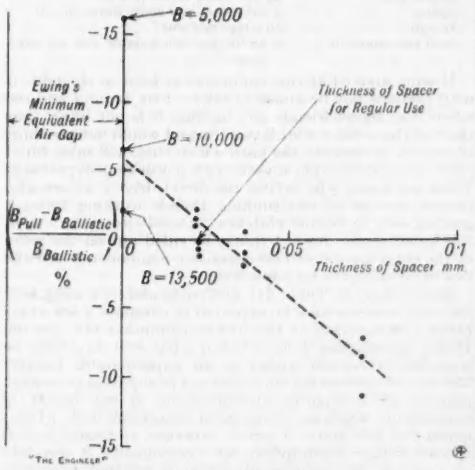


FIG. 20—EFFECT OF SPACER THICKNESS ON PERCENTAGE ERROR

use of a magnetic flexible joint which, while having constant magnetic reluctance, is yet sufficiently flexible to act as the equivalent of the knife-edge in a balance, the only variable joint remaining being the contact between the two faces where the magnetic pull is measured.

The second common source of error, *i.e.*, that caused by the tilting of the surfaces as they separate, has been reduced to a minimum by the introduction of a spacer (which, though very thin, is of a definite thickness) into the gap introduced between the surfaces where the pull is measured. A small central pin is also used to ensure correct alignment of the axes. The slightest tilting on parting, when there is

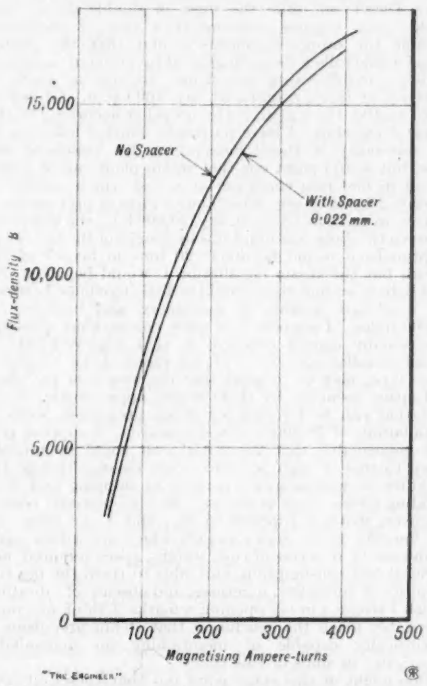


FIG. 21—EFFECT OF SPACER ON RELATION OF FLUX DENSITY AND AMPERE TURNS

no spacer, causes the flux density to increase at one edge, so that the measured pull is higher than that given by the well-known equation $P = \frac{B^2 A}{8\pi}$ dynes (B = flux density lines per square centimetre, A = area in square centimetres). At low flux densities—say, B = 5000 and lower—this excess may amount to 10 per cent. to 30 per cent. or even more.

Many years ago Ewing showed experimentally that if two surfaces were surfaced as perfectly as possible by a skilled workman, and then pressed firmly into contact, the effective air gap left from a magnetic point of view was 0·03 mm. to 0·04 mm. The spacer used in the present apparatus makes this effective gap nearly double, and, as shown by the graph Fig. 20, reduces the effect of the tilting error from, say, 10 or 15 per cent. down to 1 or 2 per cent., whilst at the same time largely reducing the irregularity of the results obtained.

In graph Fig. 21 is shown the relation of the ampère turns to the flux density developed in the specimen (i) with the spacer in position, and (ii) with the spacer removed. Clearly a theoretical curve could be drawn allowing for Ewing's "minimum equivalent" gap, and so obtaining results for an uncut specimen.

The foot-candle meter—Fig. 22—was one of the exhibits of the British Thomson-Houston Company. It has been developed to facilitate the control of the direction and quantity of light falling on the road surface. The quantity of light is measured by focusing the light on to a photronic cell and by measuring the current emitted by the cell by means of a micro-ammeter. The angle of incidence is measured by depressing a metal quadrant at the side of the meter while the reading is being taken, and release of the quadrant clamps the indicator so that the angle of inclination is recorded. If required, the vertical

FIG. 22—FOOT CANDLE METER

component can then be obtained by multiplying this by the cosine of the angle and by reference to the calibration of the instrument.

The B.T.H. brightness meter—Fig. 23—is for measuring the brightness on any illuminated surface. It consists of three telescopic tubes with an eyepiece at the top. Inside the eyepiece is a piece of glass inclined at 45 deg. to the axis of the instrument and having a small silvered portion in the centre. On looking into the eyepiece the part of the surface to be measured can be seen through the clear glass. The mirrored portion is made to reflect an internal surface and the intensity can be varied by adjusting the telescopic tubes, the position of the tubes being altered until the mirrored portion of the glass apparently disappears. The surface brightness is then determined from the position of the telescopic tubes and calibration curve.

There was also a B.T.H. reflection meter for measuring the reflectivity of various materials. Another exhibit was designed to show the effect of the use of fluorescent and luminescent materials in lamp design. These materials have the property of changing electro-magnetic radiation of high frequency into radiation of a lower frequency, in some cases with high efficiency. In incandescent filament lamps, the excess of energy not converted into light is emitted mainly in the infra-red region, and so cannot be converted into visible light by luminescent substances. However, in the case of modern electric discharge lamps a large part of the non-visible radiation is given out in the ultra-violet region, and can, by means of suitable luminescent substances, be converted into visible radiation. Such substances are now being incorporated in or used in conjunction with certain electric discharge lamps of both the high and low-pressure types to transform the ultra-violet radiation, which would otherwise be wasted so far as light output is concerned, into radiation in the visible range of the spectrum.

The materials can be used in a number of ways, but have generally to be employed at comparatively low temperatures, as at high temperatures the luminous efficiency generally decreases. Where a luminescent glass is used, the lamp or part of the envelope

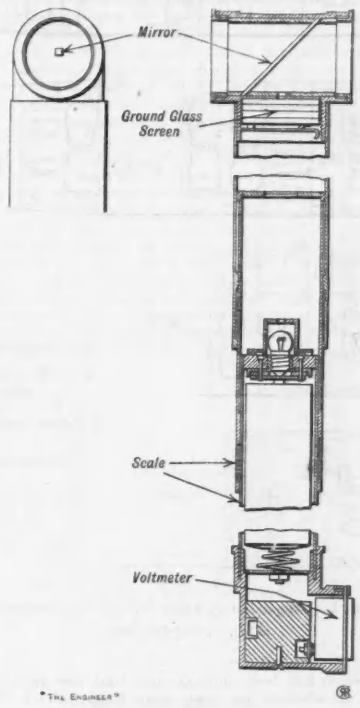


FIG. 23—BRIGHTNESS METER

can be fabricated from it. More generally a semi-opaque luminescent powder is used, which can, in the case of low-pressure mercury discharge lamps, be applied in a thin layer to the inner wall of the lamp. Some powders thus used can increase the lamp output four-fold or more. Others, giving somewhat lower efficiencies, can add shades of red and other colours in which the discharge itself may be deficient. The use of such powders is of interest in connection with discharge lamps operating at such temperatures that the inclusion of the powder within the bulb is impossible. In these cases external luminescent reflectors and filters can be used. Various examples of luminescent powders and methods of use of these in lamps were exhibited.

Other B.T.H. exhibits related to stroboscopic observations by means of special electric discharge lamps, resonance radiation in electric discharge lamps, and extra high-pressure metal vapour lamps.

(To be continued.)

The Future of Steam Propulsion.*

By JOHN JOHNSON, Chief Engineer of Steamship Services, Canadian Pacific Railway Company.

THE various forms of propulsion available to-day differ considerably in cost and in their thermal and mechanical efficiencies as well as in their practical features, and it requires much experience, judgment, and not a little foresight to decide what is likely to constitute the most profitable blend of these properties. It is not difficult to estimate the probable consumption of fuel and cost of repairs, but it is difficult to assess the value of reliability and smoothness of working, qualities which are of interest to those who provide revenue. It is not possible to translate these values into precise commercial terms, so I merely ask your assent to the proposition that if a particular system possesses these important qualities and a good case for it can be established by figures, its continuance is assured. Shipowners would prefer propelling installations to be free from noise and vibration, immune from serious breakdown, and to cost next to nothing to maintain. If completely realised, this would, of course, be a surprising state of affairs, but it is one which, I think, we shall be compelled to strive after, for the more nearly any system approximates to that standard, the more likely is it to meet with general acceptance.

GENERAL CONSIDERATIONS.

The aim which I commend to the consideration of steam engineers is that reductions of fuel consumption, weight, space, and cost should be accompanied by a rising standard of reliability and endurance. We are all only too familiar with the irritation caused by unreliable mechanical and electrical apparatus, and the disappointment and expense which a decline in efficiency and the decay of working parts entails. I do not think it by any means an impossible ideal that, with care, propelling machinery should last the life of the ship without sensible depreciation, and I suggest that any system of propulsion which does not substantially conform to this requirement is either fundamentally unsound in conception or seriously immature in design.

If the evolution of the geared turbine is carefully fostered, it ought to go far towards realising the ideal of a quiet, frictionless, and vibrationless prime mover, thoroughly reliable, and capable of performing its work for many years without undue wear. It must, of course

* Extracts from the Eighth Thomas Lowe Gray Lecture, Inst. of Mech. E., January 10th, 1936.

be partnered by steam generators and other equipment so constructed and operated that depreciation will no longer rank as a factor of importance. It might very properly be said that even if these aspirations were realised, such an installation would still leave much to be desired if the plant consumed much more fuel than the Diesel engine, occupied more space, and, in conjunction with its fuel, weighed more, because mechanical properties cannot be divorced from considerations of such importance. Let us, therefore, consider questions of weight and space.

Fig. 1 and Table I show three installations marked A, B, and C. You will observe that in a period of fourteen years the space required to accommodate the propelling

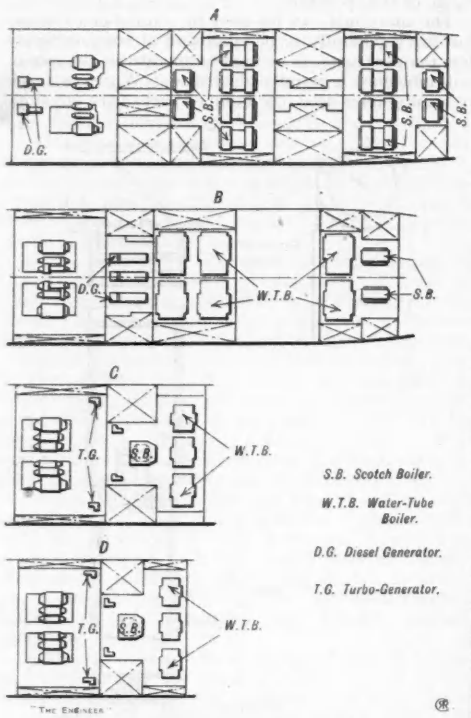


FIG. 1—*Comparison of Space Occupied by Installations A, B, C, and D (Table I.)*

installation has been halved, and that the gross weight of the installation has been more than halved. This is an illustration of what has been taking place in recent years, but it does not by any means represent finality, and I will return later to the installation designated D.

TABLE I.

Steamer.	Year built.	S.h.p.	Weight of complete installations, tons.	S.h.p. per ton.	Vol. of machin'y spaces, cu. ft.	Number of cubic feet per s.h.p.
A	1922	20,000	3400	6·0	400,000	20·0
B	1930	30,000	3500	8·5	420,000	14·0
C	1936	28,000	2150	13·0	280,000	10·0
D	1940	28,000	—	—	—	—

Let us return to the important question of fuel consumption, and employ the three same vessels for purposes of comparison. In the vessel built in 1922 saturated steam was used, but in vessel C the thermal conditions proposed are 450 lb. per square inch and 850 deg. Fah. at the high-pressure receiver, and 29in. vacuum, in association with a boiler efficiency of 90 per cent. Designs for this latter vessel are completed, but as she is not yet built I am going to ask you to take my word that the fuel consumption rate given in Table II is one that will not only be obtained on trial, but maintained in service.

TABLE II.

Steamer.	S.h.p.	High-pressure receiver.		Vac., in.	Boiler effic'ncy, per cent.	Oil consumption, lb. per s.h.p.-hr., propulsion.
		Press., lb. per sq. in.	Temp., deg. F.			
A	20,000	215	Satur'd	29	80	1·0
B	30,000	375	740	29	87	0·57
C	28,000	450	850	29	90	0·50

Half a pound of oil per shaft horse-power-hour for propulsion is an attractive rate, and corresponds to about 0·53 lb. for all purposes. I use the propulsion rate here because it is the figure which is directly and proportionately affected by the matters which we have reviewed and will shortly explore. Hotel load is independent of the mode of propulsion, and in any case can be more conveniently dealt with when the gross annual cost for fuel consumption is considered.

Comparison of the costs of machinery over a period of years is vitiated by the influence of a number of factors outside the scope of this inquiry, but it will suffice for the present if I put the cost of the plant in installation C at £10 per s.h.p. By cost, I mean the figure which would be included in the price of the completed ship for the machinery and all expenses incidental thereto.

THE IMMEDIATE FUTURE.

For the present I propose to confine my remarks to the faster type of ocean-going passenger vessel, having an aggregate power of not less than 20,000 s.h.p. The first major point I wish to make in this lecture is that an initial pressure and temperature of 375 lb. per square inch and 740 deg. Fah. respectively have already been well proven in important installations over a number of years, and that a further step forward, such as is indicated in installation C (Tables I and II), namely, to 450 lb. per square inch pressure and 850 deg. Fah. temperature, can now be taken with confidence. The general characteristics of installations of this kind may be quickly understood by reference to the following coefficients :—

Initial cost	£10 per shaft horse-power
Space	10 cubic feet per shaft horse-power
Weight	13 s.h.p. per ton
Fuel consumption ..	0·55 lb. per s.h.p.-hour for all purposes

The fuel consumption rate of 0·53 lb. per s.h.p.-hr. has been adjusted to 0·55 lb. so as to include vessels spending part of their steaming period in the Tropics. After a few years' experience of these conditions, and subject to suitable material being available for superheater tubes and certain other parts, a working pressure of 500 lb. per square inch might be adopted in association with an initial temperature of 900 deg. Fah., which would give about 7 per cent. wetness at the exhaust. The basic fuel consumption rate for propulsion under these conditions, with 29in. vacuum and a boiler efficiency of 90 per cent., would be 0·48 lb. per s.h.p.-hr.

Those whose experience in marine work has been limited to the use of a comparatively low degree of superheat, and who have not closely followed developments in power stations at home and abroad, will naturally eye this figure of 900 deg. Fah. with considerable scepticism. I think, however, that as knowledge of the matter extends and is backed by growing experience, the use of higher temperatures will become more general, not perhaps in big spurts, but in easy stages. For manœuvring purposes the initial temperature can, of course, be quite conveniently reduced 200 deg. or so by damper control.

An alternative line of development would be to adopt a working pressure of 600 lb. per square inch in conjunction with an initial temperature of, say, 800 deg. Fah. and reheat to 800 deg. Fah. at a stage which would give suitable wetness at the exhaust. It is a comparatively simple matter to design a boiler incorporating a superheater and a reheater on opposite sides of the furnace, and if the battery of boilers were adjacent to the engine-room the connections would not be unduly heavy or cumbersome. The protection of the reheater during astern working, however, seems to me a real difficulty because of the importance of maintaining full power astern for extended periods, which usually can only be done by forcing the boilers. Of course, there are very few problems in engineering that cannot be solved by ingenious design, and one cannot at this juncture rule out the possibility of a solution. One or more independently fired superheaters might meet the case, but they would involve increased weight, space, and cost. In any event, over-elaboration on board ship is to be deprecated, and unless the gains are very pronounced indeed, reheating is not likely to prove a promising line of advance. I believe that the tendency will rather be toward scrutinising every part of the main and auxiliary equipment, and jettisoning every piece of gear which does not fully earn its place. I have no actual experience myself of the value of reheating and have found some difficulty in getting reliable information, as there appears to be a good deal of difference of opinion on the point, but an economy of 8 per cent. could probably be reckoned upon by the adoption of the foregoing thermal conditions as compared with those mentioned for installation C, and would correspond to a fuel rate for propulsion of 0·46 lb. of oil per s.h.p.-hr.

I do not pretend to be able to say which of these lines of development will ultimately find most favour in the eyes of marine engineers, but my own preference is for the use of what might be called moderate pressure, say, 500 lb. per square inch, and a fairly high initial temperature, as being the most direct and simplest method for ship propulsion.

The efficiency ratio of marine turbines, such as we have been discussing, is of the order of 77 per cent. only, whereas values of 84 per cent. are commonly obtained in large land sets. While there are, of course, good reasons for this disparity, I am convinced, after a close study of the matter, that improvements in marine turbines can be made, and that a figure of not less than 80 per cent. ought to be realised.

Another avenue which remains to be explored is boiler efficiency, a matter which has received a good deal of attention in recent years. An efficiency of 90 per cent. based on the gross calorific value of the fuel does not seem to offer much scope for improvement when it is realised that this can only be maintained when the radiation losses do not exceed 1 per cent., the funnel temperature 210 deg. Fah., and the amount of air employed for combustion is not more than 10 per cent. above what is theoretically necessary. The heat rejected to the atmosphere is at a low potential ; nevertheless, it may prove both possible and worth while to recover a portion of it, at least on board ship, where circumstances are propitious and it is quite important to reduce the weight of fuel to be carried. I hope to satisfy you later that an efficiency of 95 per cent. is feasible.

Taking the most optimistic view of the several gains due to an advance in thermal conditions and improved turbine and boiler efficiencies, we arrive at a figure of

$$0{\cdot}48 \times \frac{77}{80} \times \frac{90}{95} = \text{say, } 0{\cdot}44 \text{ lb. per s.h.p.-hr. for propulsion,}$$

or 0·47 lb. per s.h.p.-hr. for all purposes.

Alternatively, taking a comparatively pessimistic view of these prospective improvements, we might get

$$0{\cdot}48 \times \frac{77}{78{\cdot}5} \times \frac{90}{92} = 0{\cdot}46 \text{ lb. per s.h.p.-hr. for propulsion,}$$

or 0·49 lb. per s.h.p.-hr. for all purposes.

If we take the mean between these two figures we shall probably not be far from the truth, and we consequently arrive at a consumption rate for all purposes of, say, 0·48 lb. per s.h.p.-hr. as being the best which is likely to be realised within the next few years.

Now, the saving of weight has not hitherto received very serious attention in the design of details of mercantile installations. I am not speaking of savings in weight by the substitution of light costly material for heavy cheap material, but the shedding of superfluous weight, without sacrifice of strength or durability, by expert trimming of scantlings. I am conscious of numerous ways in which weight can, in fact, be saved, and the reason why it has not already been done is that it was not thought to be of sufficient importance. Moreover, you will appreciate that reduction in the fuel rate brings in its train a contraction in the size of certain components, such as the main condenser and its plant, forced draught fans, and other items. As radical improvements in the design of boilers may be depended upon, I think that for this and other reasons advanced marine installations of this class built subsequent to the year 1940 will steadily approximate towards the following characteristics, which we will designate as installation D :—

Initial cost	£9 per shaft horse-power
Space	8 cubic feet per shaft horse-power
Weight	15 s.h.p. per ton
Fuel consumption ..	0·48 lb. per s.h.p.-hour for all purposes

Having arrived at this eminence, at least in thought, it may perhaps not be amiss to take a look around and see where our Diesel friends are, because it is not likely that they will have been idle all this time. I would not presume, of course, to indicate the path which they will take, but I must at least provide myself with a working hypothesis. There are many who favour the direct drive ; others who favour the use of fast-running Diesels working through gearing and hydraulic clutches. Diesel-electric drive, in the broad sense, must, I think, be ruled out on the score of the combination of two expensive components and the loss of efficiency in transmission.

Here, then, in Table III are particulars showing how the rival systems may be expected to compare a few years hence. In arriving at the fuel consumption rate for the Diesel installations I have taken what will doubtless be regarded in certain circles as an unpardonable liberty. The cost of lubricating oil, which is a heavy item generally, appears as a separate disbursement in statements of expenditure which are compiled in connection with investigations of this kind. I prefer, however, to regard it as a species of fuel consumption, for " consumed " it certainly is, and with the same regularity as is the fuel, whenever the engine is running. At quite a modest computation, expense for lubricating oil is incurred at a rate which is equivalent to an addition of 0·04 lb. of fuel to the basic fuel consumption rate.

TABLE III.

	Installation C.	Installation D.	Direct-drive Diesel.	Geared Diesel.
Cost per s.h.p.	£10	£9	—	—
Space ratio, cubic feet per s.h.p.	10	8	12	10
Weight ratio, s.h.p. per ton	13	15	8	10
Fuel consumption, lb. per s.h.p.-hr. for all purposes	0·55	0·48	0·44	0·45

In the foregoing table I have assumed that the direct-drive Diesel will take the form of double-acting two-stroke cycle engines, running at a rate of revolution suitable for propeller efficiency, and that the geared Diesel would follow the arrangement favoured in Germany, namely, double-acting two-stroke engines in units of 5000 h.p. or more, running at, say, 400 r.p.m. and geared down to 100–150 r.p.m. at the propeller according to the speed of the ship. I have purposely omitted reference to the suitability of Diesel installations for vessels of this type, but would point out that steam plant can be maintained in first-rate condition at a cost which cannot be improved upon by any other known form of propulsion.

Now, in an installation of, say, 20,000 h.p., the difference between the daily consumptions by weight of the two forms of propulsion would be about 20 tons in favour of the Diesel, but the steam installation C would be about 500 tons lighter, so that there would be little to choose between the combined weights of machinery and bunkers for 10,000 miles. I suppose it is quite conceivable, although I personally cannot conceive it, that improvements in Diesel installations, either of the direct drive or geared drive type, may be so great that the weight of the plant and space occupied by them would approximate to the best that can be forecast for steam propulsion, even in installations of 20,000 h.p. and upwards. I suppose it is also conceivable that the initial cost could be brought down to that of high-pressure steam plant, although the majority of well-informed persons in shipping and shipbuilding circles think otherwise. In high-powered vessels, however, steam is supreme to-day, and if one allows for the benefits of the improvements which are within sight, as in case D, in terms of cost, weight, space required, and reduced fuel consumption, and adds to them the positive qualities of durability, quietness, and absence of vibration, which I stressed in my opening remarks, I think one must inevitably reach the conclusion that steam propulsion is intrinsically capable of maintaining an unassailable superiority in ships of this type.

One might at this stage point out that Diesel oil costs anything from 25 to 50 per cent. more than furnace oil, and increased demand for the former for road and other forms of transport is likely to maintain this difference ; but if suppliers can get as good a price for furnace oil as for Diesel oil, they will certainly collect it. The fact is, it is impossible to foreshadow at present the number and extent of the influences which may ultimately have a bearing upon this matter. If, for example, the steam engineer's wildest dream were to come true and motor ships were to recede into the background or disappear altogether, the oil suppliers would doubtless still manage to get rid of the heavier residuals for burning in furnaces at a price satisfactory to themselves. So long, however, as there is an active demand for both qualities of fuel, it is fairly certain that Diesel oil will be the more expensive, because it is of better quality and is necessarily prepared to a stricter specification. On the relative fuel consumptions given in Table III, for case D and the Diesel drive, a difference of approximately 10 per cent. in the prices of the two grades of oil would result in equality of

daily cost, and there, I think, the matter may with confidence be allowed to rest.

Now, it may be said that, so far, the case for steam has been established only for the larger type of ship, and that even if my claims were true, they are true only for such ships, the case being totally different for those of smaller speed and power. Well, as there is much to be said for that point of view, I suggest that we cannot do better than go to the other end of the scale and consider the question afresh in relation to the tramp of 10–11 knots. Before doing so I would like to make a few observations on boiler developments, without which any consideration of this topic as a whole would be incomplete.

WATER-TUBE BOILER DEVELOPMENTS.

Water-tube boilers for marine purposes must of necessity comply with marine standards, of which immunity from serious trouble, especially in the express type of vessel, is the foremost. The intrusion of salt water is a contingency which must be kept in mind, for condenser leakages sometimes occur when it is not convenient to stop the engines, and if the water content of the boiler is small, the density will rise rapidly and priming ensue, with unpleasant and even dangerous consequences. If, notwithstanding all the care that may be exercised to prevent condenser leakages, and also in maintaining the purity of make-up feed, scale is deposited on the interior surfaces of tubes exposed to the intense heat of the furnace, it must be possible to clean them thoroughly at the first opportunity. Should tubes, unfortunately, fail at sea due to defective material, shortage of water, or because of scale deposits, it must also be possible to plug them without undue difficulty so that their renewal may be deferred until arrival at the next port. If, despite precautionary measures, corrosion does occur, replacements will be necessary, but apart from this, it is desirable as a matter of routine to cut out some of the highly rated tubes periodically for inspection, the only method by which the interior state of a long tube can be ascertained with certainty. Marine boilers must be easily repaired.

There is scarcely any limit to the number of ways in which the heating surface of boilers and superheaters may be arranged, and it is not surprising, therefore, that almost every conceivable form has appeared at some time in the history of water-tube boiler development. During the past few years, however, coincident with the active evolution of steam plant ashore and afloat, a fresh crop have sprung up, some of which differ radically from earlier conceptions. The technique underlying present-day design has for its object the production of a large quantity of steam of high pressure and temperature by a small number of units, which will be efficient, light, compact, and durable. As combustion of the fuel nowadays is almost perfect, it only remains to decide what arrangement of heating surface will best secure these objectives, in which connection I would observe that while it is perfectly true that designers have much greater latitude now than formerly because of the use of pure de-aerated feed water, it is equally true that the contingencies and requirements peculiar to marine practice, which I have just indicated, will continue to exist and cannot be ignored without risk. The propulsion of ships is a serious business, as those responsible well know, and it is not too much to say that the success of marine high-pressure steam practice depends more upon thoroughly satisfactory boiler performance than perhaps on any other factor.

In the endeavour to reduce weight and bulk, without sacrifice of efficiency and durability, it is necessary to decide what proportion of the gross heating surface shall be exposed to the direct radiation of the flames, and how the heat remaining in the inert products of combustion can be most advantageously reclaimed. Very high furnace temperatures are not conducive to the durability of tubes, especially if they are thick or not perfectly clean. Refractories and furnace front fittings suffer at high ratings and, for these reasons, there is a general tendency nowadays to envelop the furnace by tubes. So far as the convection end of the boiler is concerned, there is a tendency to use higher gas velocities, and, in some instances, very high velocities, which have to be paid for in fan power. Some increase in velocity is undoubtedly worth while in conjunction with a deep bank of closely pitched tubes of small diameter in which the gas is divided into thin streams impinging upon the alternate rows of tubes. As the drums of high-pressure boilers are heavy and costly, the fewer there are of them the better, but as some reservoir capacity is necessary for manœuvring and other purposes, at least one drum or its equivalent is indispensable. Ideas on the subject of circulation are undergoing a change, and while natural circulation by steam bubbles will suffice for moderate ratings and pressures, greater security may be obtained at higher ratings by recourse to mechanical circulation. Small-diameter tubes are suitable for high pressures on the score of lightness and cost; but, of course, they offer greater frictional resistance to flow, and it may be that an accelerated circulation will be necessary at very high ratings, such as are usual in naval practice. I think, however, that most marine engineers will prefer not to rely upon mechanism for this purpose if it can be shown that equal results may be obtained without it. The properties of any particular generator for mercantile purposes may be conveniently defined by its output per unit of weight and space at an efficiency of 90 per cent., in association with the maximum and average transmission rates on its heating surface.

The foregoing facts are, so to speak, well known in the trade, but for the benefit of those who have not had occasion to study the matter, and in order to illustrate the various points involved, we might consider a mercantile boiler complete with preheater, having a gross weight of 100 tons, inclusive of hot water. This boiler would have a generating surface of about 8000 square feet and would be capable of maintaining a steady output in service of 80,000 lb. per hour, or, say, 11,000 h.p. at an efficiency of 90 per cent. Its output, therefore, is in the ratio of 800 lb. per hour per ton of weight. Assuming the working pressure to be 500 lb. per square inch, and that the heating surface is made up of tubes of 1¾in. external diameter, the gross weight could be reduced by 6·3 tons by the substitution of 1in. diameter tubes, 4·7 tons being due to the reduction in the weight of steel and 1·6 tons in the weight of water. The omission of a water drum, 30in. diameter by 14ft. long, would effect a reduction in the weight of steel and water of 7 tons, and an increase in the average transmission rate of 25 per cent. would effect a further reduction in the weight of steel and water of 7 tons. You will see, therefore, that the parent boiler of 100 tons can, with such changes as have been envisaged, including somewhat lighter casings and supports, be reduced to 80 tons, which would give an output ratio of 1000 lb. per hour per ton of weight, as compared with 3000 lb. in a highly forced naval type boiler.

In order to illustrate these various points I have prepared Fig. 2, showing a boiler with one drum only and having fairly small tubes and assisted circulation, in which the finished weight is 80 tons, as compared with

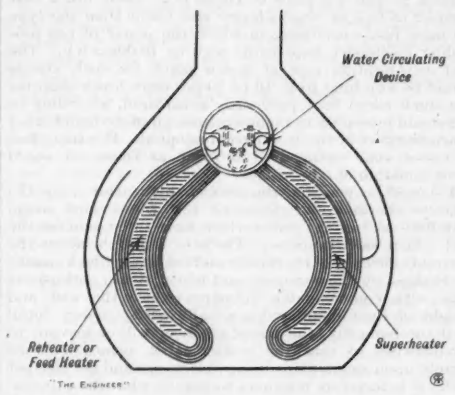


FIG. 2—*One-Drum Boiler*

100 tons in the case of the parent boiler. Loop tubes of the type shown have been cleaned quite easily with suitable tools after a heavy deposit of scale was deliberately made in them. In an installation of 20,000 h.p., cost, weight, and space can be saved by employing one double-ended unit of suitable capacity or, alternatively, two single-ended units of half the capacity in lieu of three units of one-third of the required output. In dealing with large vessels one must, however, retain a sense of proportion in these matters, for with three boilers at moderate rating there would be ample safeguard against any serious reduction in speed in the event of one of them being temporarily deranged. Practical considerations of this kind are doubtless well known to you, but one does hear occasionally of schemes in which they appear to have been overlooked.

To-day, many minds are working on different aspects of the boiler problem and much progress may be expected. I have not attempted to describe particular types in detail, but merely to state general principles, the force of which will appeal to the majority of marine engineers. I am of opinion that the high-capacity steam generator which will in future be found most suitable for use on board ship will conform to these conditions, while lending itself to such advances in pressure and temperature as the general progress of steam plant may call for. I have probably said enough to enable you to form an idea as to the order of the improvements which may be expected in terms of cost, weight, and space, as various competitive designs become available. Let us now consider in greater detail the question of boiler efficiency and the disposal of the products of combustion.

A few years ago the temperature of the funnel gases, even when burning fuel oil, was commonly in the neighbourhood of 500 deg. Fah., and the funnel was consequently an active draught-producing agent, but latterly, in the search for efficiency, the temperature has been reduced, and there are cases where at full power it does not exceed 240 deg. Fah. Now, the funnel, apart from its draught-promoting capabilities, was required to conduct the smoke and noxious gases to a position where their discharge was relatively unobjectionable, and the presence of one or more of them was considered to enhance the appearance of a vessel, to inspire confidence, or otherwise to impress the uninitiated. Nowadays, however, both the initiated and uninitiated are beginning to regard funnels with mixed feelings, for at the higher efficiencies in vogue it is difficult to prevent the products of combustion falling upon spaces set apart for recreational purposes, to say nothing of smuts and minute particles of carbon passing by way of the ventilating systems into public rooms and elsewhere. A ship after having been thoroughly cleaned and painted, sets out bravely on a voyage or cruise, and, apart from the inconveniences I have indicated, returns in a comparatively dirty condition, necessitating further expenditure on cleansing operations. Some ships are worse than others in this respect, but none of them can be said to be really satisfactory. The silhouette of a vessel having several funnels may be a joy to the beholder ashore, but its significance to those on board is slight in comparison with the amenities which could be provided for them if no space were occupied by uptakes and funnels. The disposal of the products of combustion is therefore a matter which sooner or later will have to be dealt with on more rational lines than by dispersing them in present-day fashion and leaving the rest to the direction and force of the wind.

Now, if the temperature of the products of combustion were reduced to, say, 100 deg. Fah., by spraying them with salt water, of which there is an abundance, their volume would be approximately equal to that of the air supply, which is drawn from the atmosphere for the purpose of burning the fuel. The gases would have no value in creating draught, and the funnel in that sense would be superfluous, and it would only remain, therefore, to decide how the cool and clean gases could be most conveniently discharged from the ship. There are several ways of doing this, according to the size of the vessel, situation of her boilers, and so forth, one method being illustrated in Fig. 3. If you refer to this you will see that the ducts leaving the boiler-room are extraordinarily small, even allowing for a low gas velocity. Provision is made for the gases to escape on either or both sides of the ship, according to the state of weather and direction of the wind. In really bad weather they would escape through apertures, preferably the one on the leeside, which are carried 20ft. or 30ft. above the boat deck. These apertures would be made adjustable and the resistance to flow through them would be made slightly greater than those in the ship's side, so that in the event of the latter being submerged, release would automatically occur at the higher levels.

If time permitted I could furnish you with a formidable array of objections to a system of this kind, but I think that I could also answer most of them to your satisfaction, for the subject has been closely studied for some years and discussed with pilots, navigators, engineers, naval and decorative architects, and others. I realise, however, that this innovation will have to be demonstrated on an effective scale before it will receive serious consideration, although I dare say you have noticed that under pressure of events there has been a tendency to reduce the number of funnels in certain passenger ships built within the last two or three years.

In an early part of the lecture I have referred to boiler efficiencies of 90 per cent. based on the gross calorific value of the fuel, which, of course, means that 10 per cent. of the heat of the fuel is dissipated, and it is opportune to consider at this juncture whether it may not be possible to recover a portion of that heat in association with the cooling and cleaning of the products of combustion, which I have just outlined.

The radiation loss of a water-walled, air-jacketed, well-lagged, large-capacity boiler is about 1 per cent., and 0·5 per cent. appears to be the irreducible minimum. About one-half of the remaining 9 per cent. is the latent heat of water vapour formed by combustion of hydrogen, and the other half is the sensible heat contained by the whole of the funnel gases above the temperature level of the atmosphere from which the air supply for combustion was derived. The most feasible means of recovering the greater part of this heat is to transfer it to the main condensate, which is the coldest feed water available. As this cannot be used directly on account of contamination, the alternative is to employ salt water from the main circulating discharge for spraying purposes, and to arrange for the transference of heat in an exchanger of the "Serck" type, a compact piece of apparatus capable of performing the duty with a small temperature difference. The spraying would be carried out in two stages, the first for purposes of

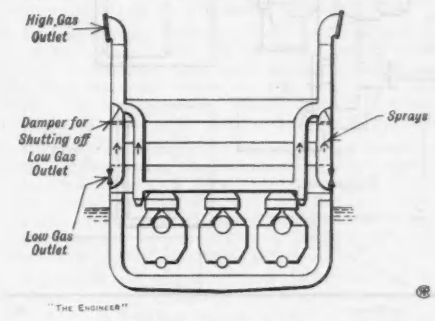


FIG. 3—*Funnelless Ship.*

heat recovery, in which the quantity of water employed would be approximately the same as the weight of feed water, and the second, in which the quantity would be sufficient to clean the gases thoroughly and fulfil other practical requirements during manœuvring, &c.

In the type of installation we are considering the products of combustion are approximately 30 per cent. heavier than the feed water leaving the main condensers, but their specific heat is only one-fourth. This means that if the products of combustion were reduced in temperature from 210 deg. Fah. to 100 deg. Fah., and the corresponding heat, sensible and latent, could be transferred to the condensate, its temperature would be raised by about 50 deg. Fah. Observations taken in vessels under my supervision have shown that although the air entering the machinery spaces from the atmosphere may be comparatively dry, it is considerably humidified before it reaches the forced draught fans, and, if, therefore, the final condition of the products of combustion approximates to that state in terms of temperature and humidity, the major part of the heat which would otherwise be wasted may be recovered, although a certain loss must necessarily occur in a heat exchanger of commercial dimensions. Hot dirty salt water is a highly corrosive fluid, but experiments have led us to conclude that materials capable of withstanding its action are now available.

I am well aware that the recovery of this low-grade heat is not an easy matter and depends upon the careful adjustment of a number of factors, but, nevertheless, it may prove to be worth while, although this can only be determined by trial on a large scale at sea. If it is not worth while, we shall at least have established that it is no use expecting efficiencies above 92 per cent., a figure which can only be attained by larger preheaters and improved oil burning arrangements, whereby the excess air can be reduced from 10 to 5 per cent.

The position, therefore, appears to be as follows:—

(1) Efficiency with funnel temperature of 210 deg. Fah., 10 per cent. excess air, and normal preheater, 90 per cent.

(2) Efficiency with funnel temperature of 180 deg. Fah., 5 per cent. excess air, and large preheater, 92 per cent.

(3) Efficiency with funnel temperature of 100 deg. Fah., 5 per cent. excess air and normal preheater plus cooling by sprays, 95 per cent.

Under present arrangements, with two-stage heating, the temperature of the feed water entering the boilers is about 300 deg. Fah. With the system of recovering heat from the funnel gases, heating by the use of bled steam in two stages would be retained, but the final temperature of the feed would be of the order of 350 deg. Fah.

THE PROPULSION OF FREIGHT VESSELS.

Much has been written in recent years concerning the merits of steam and Diesel propulsion, and the relative costs of coal and oil as fuel for freight vessels. It has to be conceded that the motor ship has made much progress

at the expense of the steamer, and that oil is now being used in both types of vessel to a much greater extent than formerly. In the case of high-powered vessels the great improvements which have been made in steam plant have been sufficient to check the advance of the Diesel engine, and, indeed, it is not too much to say that whereas ten years ago Diesel propulsion was adopted for certain high-powered vessels, its claims are rarely entertained nowadays for that class of ship. We are entitled to ask, therefore, what measure of success is likely to attend the efforts which are being made to improve the components suitable for use in steam installations of smaller power.

Steam engineers must be prepared to face the strongest case that can be stated for Diesels, and I think it advisable, therefore, to consider the cargo boat of 10–11 knots sea speed, requiring 1500–2000 s.h.p., because the fuel consumption rate reaches a maximum in the smallest steam units. The chief merit of this type of installation is cheapness and low repair costs, but in a study of this kind one must allow for progressive improvement of the Diesel engine, and I propose, therefore, to assume parity of initial cost and repair expenses, and to compare the two systems of propulsion, in the first instance, on the supposition that liquid fuel only is used in both cases.

While a simple type of turbine may with advantage be used for horse-powers of this order, there is little to be said in favour of high pressures and temperatures or for saving weight by the use of the water-tube boiler, which is essentially a high-capacity generator. The quantity of steam required for 1500–2000 s.h.p. can quite easily be supplied by an oil-fired tank type boiler, having certain practical advantages which compensate for its greater weight. The use of this type of steam generator, however, limits the working pressure to about 300 lb. per square

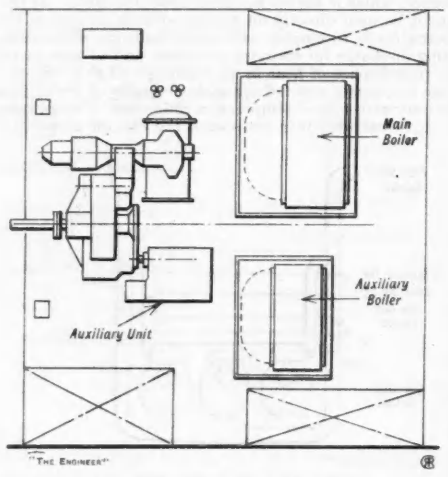


FIG. 4—*Machinery Installation for a 1,500 s.h.p. Steamer.*

inch, and I propose, therefore, to take thermal conditions of 300 lb. per square inch, 750 deg. Fah., and 28·5in. average vacuum. An air-jacketed improved type of tank boiler working at an evaporative rating of 8 lb. per square foot of heating surface and fitted with a suitable preheater, would give an efficiency of 88 per cent. based on the gross calorific value of the fuel. One such boiler would be sufficient for propulsion, but an auxiliary one of the same working pressure provided for port duty would be available for emergency duty at sea. Fig. 4 shows the arrangement of such an installation, the principal auxiliaries being driven by the main engine or, alternatively, by a small auxiliary engine. The fuel consumption would be 0·60 lb. of oil per s.h.p.-hr., and the weight of the complete installation 300 tons for 1500 s.h.p. In Table IV, which shows a comparison between steam and Diesel engines, I have assumed that a direct-drive Diesel would be employed and that the engine would be of the double-acting two-stroke type. The fuel consumption rate has been adjusted to allow for the cost of lubricating oil.

The combined weight of machinery and bunkers for 10,000 miles, or half-way round the world, would be 640 tons for the motor ship and 660 tons for the steamer.

For the purpose of this comparison I have taken the lightest steam installation capable of fulfilling the service requirements of this class of vessel, and I believe that, properly developed, it will be as cheap as the steam plant now generally employed in such ships. It certainly is more economical, but, in spite of this, you will observe that the annual fuel consumption of the steamer is roughly 50 per cent. greater than that of the motor ship, and, consequently, if furnace oil is more than two-thirds of the price of Diesel oil, the advantage must lie with the motor ship. As there can be no certainty that furnace oil will always be procurable at this rate, one must conclude, therefore, that the case for this class of steamer rests primarily upon the availability of cheap coal at ports at which the vessel normally calls, or can without undue deviation call, during the course of her voyage.

TABLE IV.

	Steam 1500 s.h.p.	Diesel 1500 s.h.p.
Space ratio, cubic feet per s.h.p.	25	33
Weight ratio, s.h.p. per ton	5·0	4·0
Fuel consumption, lb. per s.h.p.-hr.	0·60	0·43
Daily fuel consumption, tons:		
At sea	9·65	6·9
In port	2·00	0·5
Annual fuel consumption, tons (220 days at sea and 145 days in port)	2410	1590

The chief condition attaching to the carriage of merchandise is that the operation shall be profitable and not that it shall be unattended by dirt or inconvenience, and this is equally true of the type of fuel employed in cargo vessels. If coal were cheap enough, shipowners would no doubt be prepared to overlook its physical disabilities; but, as I have pointed out on a previous occasion, clean coal of good quality is the most suitable kind for ships' bunkers, and it should preferably be "sized" so as to be equally suitable for hand or mechanical firing. There does not seem to be any insuperable difficulty in doing this or in excluding inferior coal from the marine market, if the interests concerned are so minded, but these considerations immediately raise questions of costs. Now, if coal were burned instead of furnace oil in the installation under examination, the annual consumption by weight would be rather more than twice the oil consumption of the motor ship, and to be competitive, coal would have to be procurable at half the price of Diesel oil. There are a vast number of freight vessels larger and faster than the type we have just considered, in which the power of the propelling machinery may be as high as 10,000 s.h.p. The fuel consumption rate of steam plant for such vessels would be anything from 10 to 20 per cent. lower than for the small cargo boat previously considered, according to the steam pressures and temperatures employed, and other characteristics of the installation adopted. For that class of vessel, coal costing half as much as Diesel oil would show a margin of advantage.

I suggest to you that the crux of this matter is not the relative thermal efficiencies of the Diesel and steam installations, but the prices which have to be paid for the fuel which each requires. There is a gulf between the thermal efficiency of the former and the latter which cannot be bridged by the engineer, and whilst steam enthusiasts may with commendable industry reduce the cost and weight of their plant and gradually perfect every detail of it mechanically, the Diesel engineer will endeavour to do likewise, so that the matter must eventually turn mainly upon steam plant being able to use and get cheaper fuel. It is therefore pertinent to inquire what the expectations of obtaining cheap fuel for steam plant can be based upon. It has to be recognised that if there should be a superabundance of petroleum residuals, both Diesel oil and furnace oil may become so cheap as to displace coal completely as a marine fuel. There is a great deal of coal in the world, but producers may ultimately decide that it will pay them better to sell for local consumption at remunerative prices rather than incur loss by attempting to compete with oil at places remote from the areas where coal is produced. Just as there can be no certainty that furnace oil will be procurable at two-thirds the price of Diesel oil, so also can there be none that coal will be obtainable at half its price. These ratios are arbitrary and may be upset at any time by considerations of supply and demand. One can only say that as the demand for Diesel oil for various forms of transport is likely to increase considerably, it is probable that furnace oil will tend to be much the cheaper of the two, particularly as its price will always be held down by actual or potential competition from coal. It would be futile to attempt to prove that the steamer will necessarily get better value in the matter of fuel, but there are undoubtedly zones in which coal is cheap and others in which oil is cheap, and she not only has, therefore, much latitude in the matter of bunkering, but her owners are in a much stronger position when contracting for supplies. So long as there are a considerable number of efficient steam-driven cargo vessels in existence, capable of burning coal or oil, they will not only influence the cost of furnace oil, but the cost of fuel for motor ships.

As the soundness of these views will not, I think, be questioned by impartial judges, the matter may be left in this form, namely, that there is not a service to-day in which it is not well worth while making a critical comparison between the motor ship and the steamship in terms of first cost and fuel costs, &c., before a decision regarding the mode of propulsion and the kind of fuel to be used is reached. The issue of such investigations hereafter will, in a large measure, depend upon the policy adopted by those interested in perpetuating steam propulsion.

THE FUTURE OF STEAM PROPULSION.

In the course of this lecture I have extolled the advantages of the geared turbine, and will now go so far as to state that upon its general adoption and continued evolution the future of steam propulsion must depend. For powers such as are necessary for the propulsion of ships it cannot be surpassed in reliability, durability, and smoothness of working. It must, however, be linked with steam generators and auxiliary plant of the highest calibre if the combination is to be lighter and more compact than any future Diesel installation. The superiority of steam propulsion in these respects can only be assured, therefore, by sedulously improving every constituent of the whole.

Throughout this investigation I have assumed parity of first cost and repair expenses, but I am sure that our Diesel friends will have a difficult job to attain this, for with every desire to be scrupulously fair in the matter, I cannot visualise such a position being reached. Nevertheless, I think it is well to assume it because steam engineers must concentrate upon improving steam equipment rather than rely upon the known limitations or deficiencies of the Diesel engine. Most shipowners when in the market for new tonnage can be depended upon to weigh the claims of the available systems of propulsion, and there is no doubt that, although the amount may vary in individual cases, the advantage in the matter of first cost lies with steam. As regards repairs, I do know that it is possible for well-designed and soundly constructed steam installations to be operated in such a way that the cost of running repairs is almost negligible. Periodical replacements there must be, but their total cost spread over the life of the ship is really a modest amount. Whatever may be said to the contrary, the best of Diesel installations cannot yet equal the standards attained by modern steam plant at its best. Here again, then, such advantage as there is unquestionably lies with steam.

Which is the better investment—motor ship or steamship? One way of answering this question is to have recourse to statistics showing the number of vessels of each type which have been built during recent years, a method, however, which does not necessarily uncover the intrinsic merits of the rival systems, and is therefore inconclusive. A few years ago, when the Diesel was very much in the ascendancy, and the fate of steam propulsion for larger vessel hung in the balance, the opinion was freely expressed that it was only a matter of time before the Diesel engine would triumph in that quarter also. It has, however, turned out quite otherwise, for, excluding the mammoth ship, a considerable number of large high-powered vessels having steam propulsion have been built for British and foreign owners, not merely because the steam turbine is a more suitable prime mover for ships of that type than the Diesel engine, but because it was established to the satisfaction of those reponsible for the choice that when all relevant circumstances, including the cost of fuel, were considered, steam propulsion was the better investment. At the risk of repeating myself, and perhaps being wearisome, I affirm that similar conclusions may be reached for vessels of smaller power, for the reason that whereas high-powered installations have demonstrated beyond question what steam, properly applied, can do, there is not, to the best of my knowledge, a single vessel in commission in the range of 2000 to 10,000 s.h.p. which has been expressly designed for the purpose of showing what steam is really capable of, with an installation built up exclusively of the best components available.

Development of the leading types of Diesel engine has been conducted under the ægis of individual firms, each of which has devoted its efforts to the perfecting and marketing of its engine. The development of steam plant, on the other hand, has, in my opinion, been retarded because of lack of co-ordination between the several parties interested in manufacturing engines, boilers, auxiliaries, and incidental fittings. There is also a natural reluctance to scrap established types of plant and incur the expense and risk inseparable from pioneering, but unless it is done I think it must be clear to everyone that steam propulsion for smaller powers will gradually, but inevitably, decline.

Another factor of major importance is, as we have seen, the availability of suitable coal at an attractive price. Some co-ordination between those interested in the manufacture of steam machinery and the coal producers would appear to be essential. I might express this in another way, namely, that those who are engaged in promoting improvements in the design and construction of turbines, boilers, and combustion appliances for ships may do so with the utmost enthusiasm and vigour, but if there is no attempt on the part of the coal industry to give practical support to the movement, then steam engineers must resign themselves to fight the battle against the Diesel engine on its own ground, by using oil exclusively as their fuel.

No one is more painfully aware than I am of the inutility of paper demonstrations. There is only one way to complete the general case for steam and that is by the building of highly efficient freight steamers equipped to burn oil or coal, for, when liner and tramp companies are operating a number of really up-to-date steamers as well as motor ships, they will have a clearer understanding of this problem than is possible to-day, and steam engineers should welcome and encourage practical comparisons of that kind. It will be necessary for the steam and coal interests to satisfy owners that the modern steamer will not only be cheaper than the motor ship, but that it will carry the same weight or volume of cargo on a smaller expenditure of fuel, and that it will cost less to maintain in an efficient condition throughout its lifetime; in short, that it will be, in the true sense of the term, a better investment. After having closely studied this matter for some years, I have reached the conclusion that if the cause of steam propulsion is prosecuted with resolution and vigour by those who have its interests at heart, these claims can with few exceptions be substantiated. The optional use of coal or oil is a "trump card," for fuel independence is bound to make a strong appeal to shipowners, irrespective of their nationality. Steam engineers, therefore, must devote themselves to improving their plant in every essential particular, in order that owners may, without hesitation or penalty of any kind, avail themselves of this advantage, and I hope that I have succeeded in convincing you that the matter is well worth the efforts of those who believe in the future of steam propulsion.

RAILWAY COALING PLANTS.

IMPORTANT improvements and alterations are being carried out at the locomotive depôt at Tay Bridge, Dundee, of the London and North-Eastern Railway. Being on the main Edinburgh–Aberdeen line, the depot has to deal with the "Cock of the North" and other heavy types of locomotive, and about 800 locomotives are accommodated there. Improved methods of coaling these locomotives are to replace the raised coaling stage at present installed. The new plant will have elevated storage hoppers, and the bunkers will be loaded by an electrically operated skip hoist, which will raise the coal previously tipped from wagons at ground level. The plant will have a capacity of 300 tons divided into first-class and second-class coal, and should be capable of dealing with future requirements of the depot for some time to come. In addition, a new building will be erected to house all the machines required for heavy locomotive repairs. A wheel drop will be installed. The latest type of sand drier, a new engine pit, and additional facilities at Tay Bridge passenger station for carriage cleaning are further improvements. At Fleetwood Harbour, Lancs., the first of six new coaling plants has been erected by the L.M.S. Railway. It forms part of the £85,000 improvement scheme to be carried out. Six electrically operated belt conveyors, capable of dealing with 20-ton wagons, will replace the present system of bunkering trawlers by means of cranes and buckets. With the completion of the new appliances the L.M.S. will take over the whole of coal-shipping work, including trimming.

SIR VALENTINE G. CRITTALL, chairman of the Crittal Manufacturing Company, Ltd., has accepted an appointment as President of the British Works Management Association in succession to Mr. E. J. Fox, managing director of the Stanton Ironworks Company, Ltd. The Vice-Presidents of the Association are Lord Amulree, Sir Steven Bilsland, Bart., Mr. Frank Hodges, Mr. E. S. Byng, and Mr. Sam Mavor.

Rail and Road.

A NUMBER of people were injured and one of the drivers killed when the Penzance to Paddington passenger train collided with a coal train near Shrivenham, early on Wednesday morning. The official statement issued by the Great Western Railway says that the engine and first three coaches of the passenger train were derailed.

THE issue of the traffic returns for the fifty-second week shows that, compared with the fifty-two weeks of 1934, the G.W. had an increase of £274,000, the L.N.E. one of £198,000, the L.M.S. of £891,000, and the Southern £188,000. The total for the four main line companies is returned as £1,551,000 higher than in 1934, of which sum £1,184,000 came from passenger traffic.

THE general managers of the main line companies and the representatives of the railway unions had a further meeting on January 7th as to the complete restoration of the wages cuts made in 1931. It was subsequently officially announced, at the close of a four hours' session, that "after a full discussion of the position it was agreed that the meeting should stand adjourned."

THE *Great Western Railway Magazine* for January reveals a useful public service rendered at the time of the General Election on November 14th. Special newspaper trains were run and facilities were afforded to the newspaper staffs to join the regular newspaper trains at various stations *en route* for the purpose of inserting "stop press" paragraphs giving the latest election results.

THE L.M.S. Railway has completed the first of a new series of passenger locomotives of the 2–6–4 tank type, of which seventy will be constructed at the company's Derby Works in 1936. These engines will be employed principally on fast suburban trains in various parts of the system; each engine weighs 91 tons and, like an express tender engine, is fitted with pick-up gear to enable it to take water from track water troughs at speed.

WE learn with great interest from Richardsons Westgarth-Brown Boveri that a Velox steam generator is to be fitted to a 4–6–0, 2400 i.h.p. locomotive. The order comes from the Office Central d'Etudes de Materiel de Chemin-de-fer, so we conclude that a series of scientific tests of a searching nature will be carried out. The capacity of the generator is to be 26,400 lb. per hour at a pressure of 270 lb., with a temperature of 715 deg. Fah. The feed temperature will be 212 deg. Fah. and the fuel oil.

DURING the three months ended June 30th last, there were thirty-four inquiries into the more serious accidents to railway servants, of which fifteen were fatal cases. The causes assigned in the fifteen instances were: Want of care seven, misadventure three, no look-out man two, accidental one, lack of proper understanding between two men one, an impulsive movement one. In one of the cases said to have been due to misadventure the man's mates saw that he was in a position of danger, but they contented themselves with a verbal warning. Each man carried a whistle, but in such a position in their clothing that they could not be got at readily.

FIGURES extracted from a police census taken at important points in London during twelve hours on a weekday in July last have recently been published. The busiest hour was between 6 p.m. and 7 p.m. when the number recorded was 309,760, a percentage of 10·29 of the total of 3,010,670 for the twelve hours. The nearest approach to that hour was from 5 p.m. to 6 p.m., when the total was 308,956, and the percentage 10·26. Of the classes of vehicles recorded there were 1,124,415 private cars, or 37·4 per cent. of the whole; pedal cycles numbered 623,494; light commercial motor vehicles, 494,448; buses, 285,256; and heavy commercial motor vehicles 100,234.

THE Ministry of Transport railway statistics for September also gave the figures for the nine months ending September 30th. They show that, compared with the corresponding period of 1934, there was an increase of 4·6 per cent. in the number of passenger journeys, of 3·5 per cent. in the receipts from passengers, and of 2·7 per cent. in the receipts from passenger traffic generally. Coaching train mileage rose by 2·3 per cent. In freight traffic there was a fall in tonnage and in receipts. In tonnage there was a decrease of 1·2 per cent., of which merchandise accounted for a fall of 1·2 per cent., minerals and the merchandise included in Classes 1 to 6, 1·1 per cent., and coal, coke, and patent fuel, 1·3 per cent. Livestock rose by 1·7 per cent. The drop in freight traffic receipts was only 0·5 per cent., and the merchandise receipts just managed to hold their own, having advanced by 0·2 per cent.

ADDITIONALLY to the earlier derailment of October 14th, 1913, at New Galloway, there was, on December 24th, 1922, another derailment on the Portpatrick and Wigtownshire line. That was at Cree Viaduct, and concerned a passenger train and the whole of the eleven vehicles, except the last one, were derailed. High speed—not less than 60 m.p.h.—coupled with a ¼in. to ½in. wide-to-gauge and a worn rail, set up oscillation and led to the derailment of one or two of some four-wheeled vehicles which were in front. Major Hall, in his report on the accident, drew attention to the presence of this type of vehicle on express passenger trains, and made two recommendations: (1) In any passenger train on this branch four-wheeled vehicles should be marshalled behind all bogie or six-wheeled passenger stock; (2) the maximum speed of the train concerned in this case, and of others similarly timed was such as might reduce the factor of safety of trains of this character to an unusually low value. The maximum speed of such trains should be restricted and a correspondingly longer time allowed between the stations concerned. Major Hall also drew the attention of railway companies generally to the question of the hornblock and axle-box fittings of vehicles of the type in question, with a view to provision being made, if it did not already exist, for sufficient play between axle-box and hornblock bridle to obviate any risk of a wheel being lifted when oscillation is set up. The Ministry of Transport inquiry into the derailment at Parton on December 30th last was conducted by Colonel Trench on Tuesday, January 7th. No light was thrown on the cause of the accident.

Miscellanea.

THE British Standards Institution has recently issued for public criticism and comment a new draft Specification for Methods of Testing Bore-hole and Well Pumps, Sewage Pumps, and Vapourising Liquid Pumps. This specification will form a supplement to the recently issued British Standard Specification No. 599, Tests for Clear Water Pumps.

IT is announced that Lord Hirst of Witton has accepted nomination as President of the Federation of British Industries for the coming year. Lord Hirst has, during his chairmanship of the Empire Committee in recent years, rendered signal service to the F.B.I. Lord Aberconway, of Thos. Firth and John Brown, Ltd., and Mr. A. H. Kilner, of Courtaulds, Ltd., have been nominated as additional Vice-Presidents of the Federation.

THIRTY-THREE filling stations have set up pumps supplying motorists with petrol made by low-temperature carbonisation from British coal since the first of them was opened last month. Eight of the new pumps are in London, seven are in Sussex, four in Kent, four in Herts., three in Surrey, two in Essex, and others in Bedfordshire, Gloucestershire, Hampshire, Middlesex, and Somerset. Sites for a further twenty-two are in prospect. Each pump carries a globe shaped like a sack of coal.

AN article in the *Contract Journal* gives particulars of a report by the City Engineer of Sydney on his investigations into the use of pigments for colouring concrete for paths, seats, &c. Samples were made with 2 to 1 mortar using pigments up to 12 per cent. of the cement. Portions of these were protected from the sunlight and the specimens exposed for seven days. It was found that mineral oxides were the only colours unaffected and that organic pigments faded badly, especially in the case of black colours. The intensity of colour produced by the pigments was found to depend on the fineness of the powder as much as on the shade of the colour itself.

THE Official Returns rendered to the Electricity Commissioners show that 1929 million units of electricity were generated by authorised undertakers in Great Britain during the month of December, 1935, as compared with the revised figure of 1557 million units in the corresponding month of 1934, representing an increase of 372 million units, or 23·9 per cent. The number of working days in the month (*i.e.*, excluding Sundays and Bank Holidays) was twenty-four, the same as last year. During the year ending December 31st, 1935, the total amount of electricity generated by authorised undertakers was 17,565 million units, as compared with the revised figure of 15,462 million units for the corresponding period of 1934, representing an increase of 2103 million units, or 13·6 per cent.

SIR ROY ROBINSON, Chairman of the Forestry Commission, in a lecture to students and others associated with the timber trade, said that according to a census taken in 1924 there were then about 3,000,000 acres of woodlands in Great Britain. Of these about two-thirds could be classified as economic woodlands and the remainder scrub and devastated woodlands. Since the war there had been 300,000 acres planted by the Forestry Commission, and about 150,000 acres by private landowners. These were mainly in conifers, Scotch pines, and Douglas firs. There was still a great deal to be done in this country, not only in growing better timber, but in making better use of what we had. We should always have to rely to a great extent on imported timbers for the bulk of our requirements, but it was essential to have in this country substantial reserves to rely on in emergency.

MEASUREMENTS at the National Physical Laboratory, averaged over a period of ten years so as to eliminate the effects of varying meteorological conditions, show that the light from the whole sky is about eight times as great at 9 a.m. on a June or July morning as on a January morning. The average June noon is four to five times as bright as a December or January noon, and at 3 p.m. the illumination is nearly ten times as great in June as in December. In January the average illumination in foot-candles from the whole sky is 405 at 9 a.m., 850 at noon, and 390 at 3 p.m. The results of measurements for each month from the whole sky and from each quarter of the compass are given in a "Report on the Seasonal Variation of Daylight Illumination" issued by the Department of Scientific and Industrial Research (Illumination Research Technical Paper 17, published H.M. Stationery Office, 4d. net). The average values of daylight illumination to be expected at different times of the day throughout the year are of importance to architects and others concerned in the natural lighting of buildings. The Report contains the results of measurements made at Teddington, but measurements in other localities are being initiated, while more detailed results are expected from the use of a recorder employing a photo-electric cell which is now being used in the work.

A STRIKING example of speed in the manufacture and installation of heavy electrical plant is reported from Sunderland, where a new mercury arc rectifier has been put into commission within seven weeks of the breakdown of the original equipment. The traction plant at the Corporation electricity station broke down on October 26th, and the following day a specification was prepared and sent to electrical manufacturers. On October 31st the tender of the General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2, and Witton Engineering Works, Birmingham, was accepted, and the next day the company received the order. Dispatch from Witton was promised in six working weeks. Two 16-ton loads were brought by road from the works, and on December 21st the plant was completed and put into commission to take the tramway load for the Christmas Eve football match. The new rectifier equipment is rated at 1500 kW, and is capable of converting from 5000 volts A.C. to 550 volts D.C. for use by the trams. It has 50 per cent. more capacity than the old machine and is capable of taking the whole tramway load. Two of the old machines, one of which broke down, are being scrapped, and a second new rectifier will be installed by February, providing a complete stand-by plant. The rectifier is fitted with a smoothing circuit in order to prevent interference with wireless reception in Sunderland.

Air and Water.

IT is proposed to enlarge the entrance to Whitehaven Harbour to enable ships of 2000 tons to be berthed.

A DIRECT passenger service between Dublin and New York will be opened by the Anchor Line in May next.

A NEW service, for passengers and cargo, has been begun between Southampton and the United States ports of Baltimore and Norfolk.

FOURTEEN passengers and a crew of three lost their lives when an American transcontinental air liner crashed near Goodwin, Arkansas, on Wednesday.

ONE of the largest vessels yet handled by the Glasgow shipbreakers, the 3399-ton oil tanker "Natica," has arrived in the Clyde for breaking up.

DURING 1935 Danish shipyards delivered twenty-nine new vessels to home and foreign firms and there are at present twenty-nine ships under construction or ordered.

IT is the intention of Pan-American Airways to erect hotels near to the air bases at Midway, Wake, and Guam islands on the Trans-Pacific air route. Many applications have already been received for the first passenger carrying flight.

IT is planned by Imperial Airways to train some 180 seaplane pilots during the next three years, as part of the preparation for the ultimate substitution of flying boats for land planes on various sections of the Empire air routes.

THE Government of South Africa is arranging the construction of emergency landing grounds at 50-mile intervals along all air routes. It is expected that within a few weeks the wireless triangulation of the Union will be completed.

IN co-operation with the American industry, the U.S. Bureau of Air Commerce has developed a device for clearing the ice which forms on airscrew blades. According to *Flight*, the device consists of a "slinger ring" which provides for a continuous flow of anti-ice solution. Three tubes extend from the ring along the leading edges.

THE battleship "Revenge," flagship of the First Battle Squadron of the Mediterranean Fleet, arrived at Portsmouth on Saturday last, after serving a commission in the Mediterranean, where she has been since August, 1934. The battle-cruiser "Renown," from Gibraltar, is relieving the "Revenge" in the Eastern Mediterranean.

FOLLOWING a remarkable increase in air mails to and from London during the latter part of 1935, figures are now available which show that the recent Christmas mails flown from London were the heaviest ever dispatched, including more than 500,000 letters to destinations along the Empire routes, in addition to a record-breaking volume of seasonable parcels.

ACCORDING to official returns issued by the Great Western Railway Company, the trade of its six Welsh ports, Cardiff, Swansea, Newport, Barry, Port Talbot, and Penarth, from January 1st to December 15th last totalled 23,927,615 tons, against 24,464,302 tons in the corresponding period of 1934. Exports were 20,410,705 tons, compared with 21,037,139 tons a year ago, and imports 3,516,910 tons, against 3,427,163 tons in 1934.

TEN of the twenty-six vessels now being built at Tyne shipyards are to be launched by the end of February. The first launch on the river this year took place on January 8th from Messrs. Hawthorn, Leslie and Co.'s yard, the vessel being the motor coaster "Beal." Among the other vessels to be launched within the next few weeks are the cruisers "Newcastle" and "Sheffield" and three destroyers, a cargo ship, a passenger and fruit-carrying liner, and a fruit-carrying motor ship.

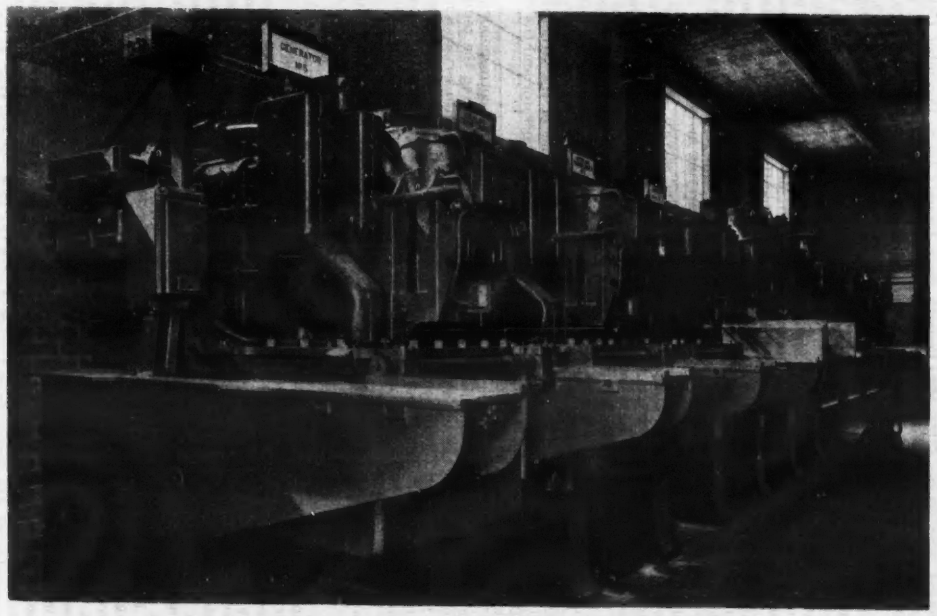
INTENDED for the service between this country and the River Plate, the Lamport and Holt Line has ordered from Harland and Wolff, Ltd., a new oil engine propelled cargo liner of 10,000 tons deadweight and capable of a speed of 15 knots. One of the unusual features of the vessel will be the single large funnel, of which only a small portion will be needed to carry the exhaust pipes from the engines, and the remainder of the structure will include the rooms of the wireless operator and the captain's bathroom.

A REPORT of *The Times* Berlin correspondent says that the Deutsche Lufthansa is celebrating the tenth anniversary of its foundation by putting into service a new high-speed passenger aeroplane. It is a twin-engined underslung monoplane, capable of carrying ten passengers and luggage at a maximum speed of about 220 m.p.h. and a cruising speed of 190, but which, when equipped with two 880 h.p. engines that are being made for it, will have a maximum speed of over 250 m.p.h. and a cruising speed of 217. This new aeroplane, the "He.111," will displace the "He.70," which has a maximum speed of 236 m.p.h. and accommodates only four passengers.

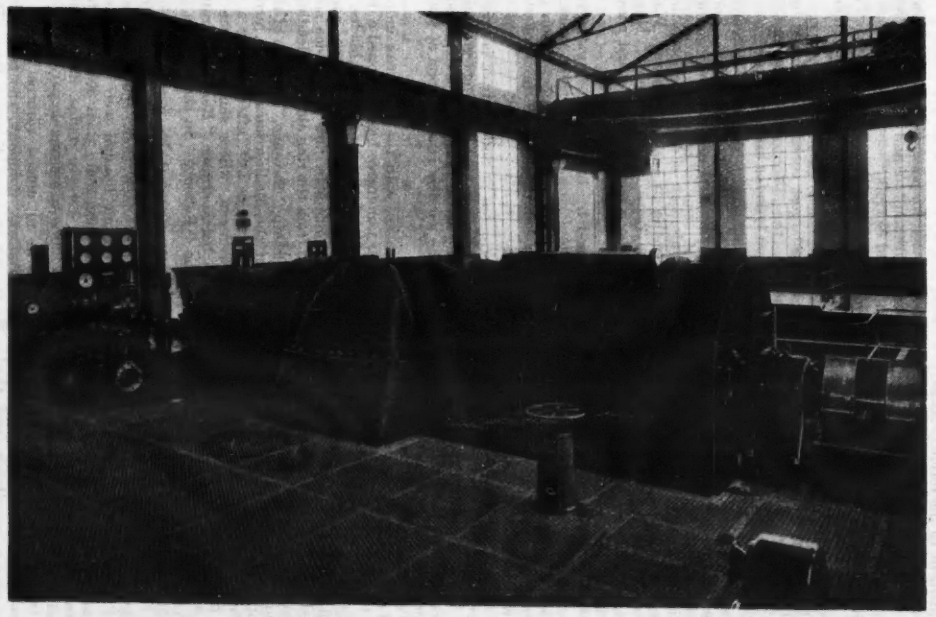
IN a paper before the Royal Aeronautical Society, Mr. J. E. Hodgson said that there must be many who do not realise the extent of the work of Sir George Cayley. He was born at Scarborough in 1773. It appears that he made his first experiment with a so-called Chinese flying top in 1792, and his last reference to flying, in his detailed records, was made in 1855—at the age of eighty-three. During the intervening period his experiments, in the light of modern knowledge, were unbelievably advanced. Close studies of bird flight enabled him to form surprisingly accurate ideas on wing loading. In 1804 he started a series of experiments—the first of the kind ever made for purely aerodynamic purposes—with a pivoted form of whirling arm. These led up to his first glider, working on the principle of the inclined plane. He appeared to be so satisfied with the performance that he spent the most of the following thirty or forty years in search of a means of propulsion. During this period he constructed a glider weighing 561 lb. and loaded with 841 lb., or 2 sq. ft./lb. This, when launched from a hill, sailed downward with varying stability according to the rudder setting. He made several other machines which, incidentally, led him to invent the tension or bicycle wheel as "being the lightest possible for aerial navigation."

PRETORIA ELECTRIC POWER STATION

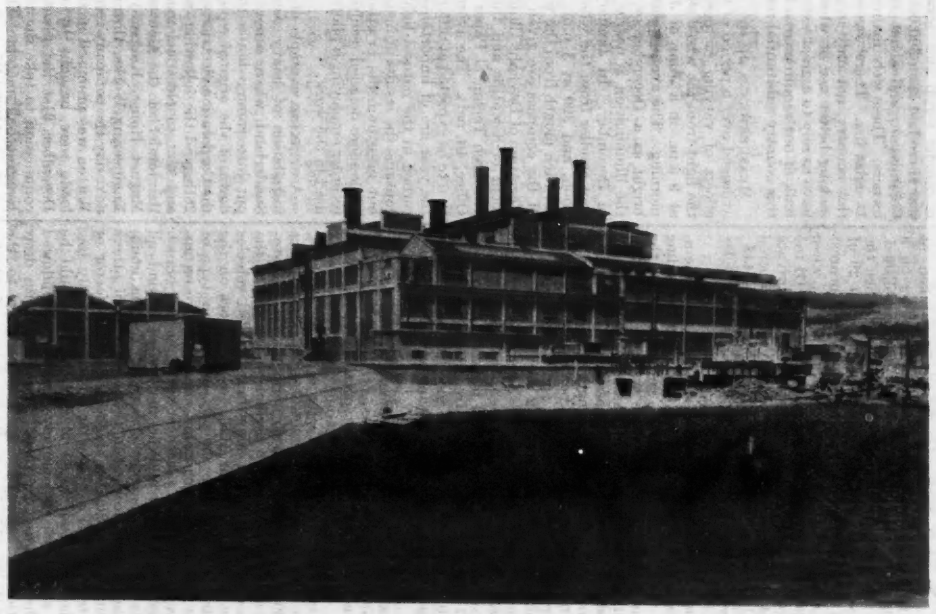
(*For description see page 67.*)



ELECTRICAL SWITCHGEAR



TURBINE ROOM



WEST END OF POWER STATION

CONTROL ROOM

The Engineer

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Contents.

THE ENGINEER, January 17th, 1936. PAGE

A SEVEN-DAY JOURNAL ... 63
AMERICAN BEACH AND SHORE PROTECTION WORKS. No. I. (Illus.) ... 64
PRETORIA'S ELECTRICITY UNDERTAKING. (Illus.) ... 67
THE PHYSICAL SOCIETY'S EXHIBITION. No. II. (Illus.) ... 69
THE FUTURE OF STEAM PROPULSION. (Illus.) ... 71
RAILWAY COALING PLANTS ... 74
RAIL AND ROAD ... 75
MISCELLANEA ... 75
AIR AND WATER ... 75
LEADING ARTICLES—
Mining and Mystery ... 77
Steam Propelling Machinery ... 77
LITERATURE ... 78
BOOKS RECEIVED ... 78
BRITISH RAILWAYS IN 1935 ... 79
MODELS USED BY SIR CHARLES A. PARSONS. (Illus.) ... 81
LETTERS TO THE EDITOR—
Single-arch Masonry Dams—The British Institute of Philosophy—The "Graf Zeppelin"—Locomotive and Small Scale Tests 82
Turbomotive ... 83
TWO NEW BORING MACHINES. (Illus.) ... 83
L.M.S. 2-6-4 PASSENGER TANK ENGINE. (Illus.) ... 83
SIXTY YEARS AGO ... 84
THE MANUFACTURE AND TESTING OF ROLLING STOCK EQUIPMENT. (Illus.) ... 84
BRITISH STANDARDS INSTITUTION ... 84
CONTRACTS AND ORDERS ... 86
LAUNCHES AND TRIAL TRIPS ... 86
MARKETS, NOTES AND NEWS ... 87
CURRENT PRICES FOR METALS AND FUELS ... 88
FRENCH ENGINEERING NOTES ... 89
BRITISH PATENT SPECIFICATIONS. (Illus.) ... 89
FORTHCOMING ENGAGEMENTS ... 90
PERSONAL AND BUSINESS ANNOUNCEMENTS ... 90

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**** No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

CHANGES OF ADDRESS.

**** Will subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

MINING AND MYSTERY.

THE decision to postpone for a fortnight the circulation of strike notices encourages the hope that some means may yet be discovered of avoiding a stoppage which would wreck the coal-mining industry and bury other industries in the ruins. The principal factor in the attainment of that end is the preservation of an even temper on both sides of the dispute. If hot words and hot actions can be prevented it is not past hoping that facts and arguments will carry their due weight with the colliery workers and that they will consent to take all that can be reasonably and economically offered to them, and will not hold out for the satisfaction of impossible demands. It has been frequently said during the past few days that the sympathy of the public is with the miners, but that they will lose it if they persist in asking for more than the industry can pay. It cannot be unknown to them that whilst a few mines are making a small profit the accounts for all the mines in the country as shown by the latest return show a deficit instead of a profit. In such circumstances a general increase of wages must be drawn principally from other industries by a rise in the price per ton of coal. That must inevitably make it more difficult for the industries affected to compete with their goods in open markets unless they can reduce the consumption of coal per unit of production. That they will endeavour to do, and if they succeed, as they certainly will in a greater or less degree, the demand for coal will decline still further. It is strange that it should be necessary to insist that the increase in the price of a commodity leads directly to the search for the means of economising it and, hence, to a reduction in the quantity bought per unit of production. In the old days when railway companies could purchase coal for 5s. a ton, the question of the thermal efficiency of locomotives was not of much consequence. Now that it costs about five times as much all means of reducing consumption are being examined. Broadly, it may be said that the real salvation and restoration of British coal mining lie in the discovery of technical or economical means of reducing the price per ton, and that its further decay will be hastened by any course which raises the price.

Calm and dispassionate discussion of such economic problems as these is required not only between the coal owners and the coal miners, but on the part of the general public as well. For this reason we welcome an anonymous pamphlet, entitled "Miners, Owners and Mysteries," which is now, we understand, on sale on the bookstalls for a few pence. In details this brochure is open to some criticism, but, regarded broadly, it has the merit of being free from bias and of stating fairly the arguments for both sides. Moreover, taking it for all in all, it is correctly informative, and with its help the general reader may avoid some of the pitfalls with which, to the uninitiated, the colliery industry "bristles." Into some the author himself unfortunately falls, as, for example, his mistaken belief that "caviling" causes loss of output, or that the coal-mining industry is comparable with the mechanical engineering industry. We venture to commend particularly a chapter entitled "Economic Difficulties," in which the author discusses such questions as quotas, the operation of coke-oven and by-product plants by colliery companies, and depreciation, and touches upon the very vexed problem of selling. He observes that "the quota system is a source of much dissatisfaction in some quarters, and warm comfort in others," and we gather from his own comments that he is to be numbered amongst the former. We cannot imagine any mining engineer supporting the quota system save as a palliative. As in other industries, his costs per ton fall as his output rises, and anything, such as a quota, which does, or tends to, check his output, increases the cost of production. As our author remarks: "The difficulties of a mining engineer responsible for a group of collieries laid out for the economical production of, say, 6000 tons per day, are very considerable if he is only permitted to get 4000 tons and has to purchase the right to work an extra thousand or two tons at anything from 3d. to 9d. a ton." On the question of the profits of subsidiary undertakings upon which the miners have laid undue stress—for their representatives themselves signed the agreement upon the method of auditing and accounting—the pamphlet points out that if the subsidiary concern failed to make a profit it might collapse with the obvious reactions upon the coalfield. Surely, it must be manifest that the prosperity of any industry using coal is of immediate moment to the coal producer. The greater its success the more the coal it will consume and the higher will be the price it can pay. "Ultimately," says our author, "and whatever the organisation of the industry, its prosperity depends upon the possibility of getting a sufficient price for its product to meet its expenses and show a profit. The expenses of production may be reduced in one way or another, but the industry must be able to pay adequate wages, earn enough to set aside proper reserves and depreciation, and provide a sufficient dividend to attract money into it. Merely increasing prices will not necessarily do this, since increased prices invariably mean reduced demand."

We have purposely refrained from detailed criticism of this pamphlet because, though some of the errors are not without danger, the general question is far more important than the items of which it is composed. This general question is fairly discussed in a manner which should keep the uninformed reader from acquiring a bias which may prejudice him against one party or the other. The problem that has to be investigated is not whether all coal owners are ignorant, indolent, and hide bound, nor whether all colliery workers are irrational hot heads, but the means of putting the industry of coal mining once more on an economic basis. That that can be done by increasing the price of coal is assuredly a fallacy, leading to many undesirable consequences. The revival of the industry turns ultimately upon its ability to reduce its prices so that increased consumption may result. If that can only be done by decreasing the amount of labour employed per ton, or by closing altogether unprofitable pits, it would be wiser to take such heroic measures with the hope of not very distant gain than to pursue an uneconomic path which will inevitably lead to further distress. By the latter plan the further diminution of the coal-mining industry is inevitable; by the former, however hard it may be, there is a reasonable hope of a return to health. Unfortunately, it is now impossible to pursue a purely economic course for the hardship which mine workers are suffering, owing rather to short hours than to low wage rates, is manifest and something must be, and is being, done to alleviate it. But a return as quickly as possible to sound economic conditions is imperative.

Steam Propelling Machinery.

IN the eighth Thomas Lowe Gray Lecture, an extract from which appears in our present issue, Mr. John Johnson gave on Friday evening, at the Institution of Mechanical Engineers, a closely reasoned and valuable analysis of the present position of steam propulsion and outlined the prospects which, in his view, it holds for the immediate future. It is satisfactory to note that under the influence of the keen competition of the oil engine, which shows little sign of any decrease in intensity, modern steam propelling machinery has in the last few years gone forward and has achieved results which have placed it in a leading position for ships of higher power. The essential qualities in ideal propelling machinery, apart, as Mr. Johnson rightly points out, from its first cost and the fuel and lubricating charges, include freedom from noise and vibration, immunity from serious breakdown, and a low maintenance cost. In the geared steam turbine, which is able to utilise highly superheated steam, without internal lubrication, and which can be worked at its full designed power over a long term of years without depreciation, the lecturer sees a type of steam engine which, the smaller powers apart, must ultimately displace all other types. Makers of reciprocating steam engines may not agree with this wide statement, but even if they do not, we may point out that during last year the low-pressure steam turbine was increasingly used in connection with the reciprocating steam engine, in order to increase further the working efficiency. An important point which Mr. Johnson stressed is that future progress in steam propelling machinery largely depends on the closer collaboration between the makers of steam generators, steam turbines, condensers, and auxiliary machinery, so as to ensure that the individual components of the propelling installation are each the very best of their kind, and will combine to build up a complete unit, favourable in price, light in weight, small in dimensions, and which will operate quietly and automatically with low fuel and maintenance costs and freedom from breakdown. On the production of such a unit by steam engineers—in close association, we would suggest, with the fuel interests, to ensure the most economical fuels, with, if possible, optional use of coal or oil—further progress in steam propelling machinery depends.

In the first part of his lecture, Mr. Johnson gave valuable operating results of the turbine machinery which he has designed and installed in several ships built during the last fourteen years, and showed that over that period, considering machinery of from 20,000 to 28,000 s.h.p., the weight of the complete installation has been reduced by one-third, the shaft horse-power per ton weight more than doubled, and the space taken up per shaft horse-power halved. By doubling the steam pressure from 250 lb. to 500 lb., and increasing the total steam temperature to 850 deg. Fah., and with a boiler efficiency raised from 80 to 90 per cent., the fuel oil consumption per s.h.p. hour for propulsion only has been reduced from 1·0 lb. to 0·50 lb. By exercising greater care in the design and arrangement of the boilers and making possible a still further recovery of radiated heat, and that still remaining in the flue gases, even assuming a moderate steam pressure of 500 lb. per square inch, Mr. Johnson foresees an advance to 95 per cent. in boiler efficiency, which would give a fuel rate, for propulsion only, of 0·46 lb. per shaft horse-power hour. The operating experience with Canadian Pacific liners and cargo ships, referred to in the lecture, shows that there is still room for further advances to be made in the quality of the materials used for turbines and blading, the method of attaching the wheels, and the testing of wheel assemblies. The condenser and the feed system, with the auxiliary pumps, have their own problems of materials and design, which while they have largely been solved for power station work, still afford scope for improvement in the marine field. Gearing, too, has shown a much better performance during the past decade, and it may now be regarded as a satisfactory link in the chain. In order that the confidence now established may be maintained, there should be no slackening in effort on the part of designers and manufacturers to secure quiet running coupled with greater dura-

bility. In the last section of his lecture Mr. Johnson considers the relative merits of steam and oil engine propulsion for cargo vessels, and examines the case for a cargo vessel of 10 to 11 knots sea speed, requiring, say, 1500 to 2000 s.h.p. This is a type of ship for which special engines and hulls have been designed, and for which authoritative and reliable figures are now available. The oil engine case is an exceedingly strong one, but it is shown that with modern turbine plant of simple and highly efficient design, coupled with the most modern boiler plant, results can be expected which with favourable conditions of fuel cost make the steamers a good investment. The crux of the matter is, it is pointed out, not in the relative thermal efficiencies of the steam and the oil engine, but in the prices of fuel which each vessel has to pay. These prices vary on various trade routes, and in many instances cheap fuel oil has favoured the motor vessel and has led to repeat orders for such ships being placed. This is particularly the case in the range of cargo ships employing machinery between 2000 to 10,000 s.h.p., in which, Mr. Johnson states, there is not a single ship now in commission which has been expressly designed to show what steam is really capable of doing, and built with the best components now available.

This year's Thomas Lowe Gray Lecture is the work of one who has done more than perhaps any other marine engineer of recent years to advance British marine engineering prestige on its steam side, and whose proposals are backed by sound experience. Again, as he did four years ago in a Naval Architects' paper, Mr. Johnson makes a strong plea for the construction of highly efficient cargo liners and tramp ships, which will be equipped to burn either oil or coal, and can, he assures us, be relied upon to give a highly satisfactory performance. Shipowners and steam engineers should consider his arguments, and while giving careful study to the best results obtained with motor ships, should seek to improve still further the performance of the steam-driven ship. There have been many recent advances in boiler design, some of which tend to give a higher efficiency, but only at the expense of greater complexity. These developments have encouraged the production of new types of tube boilers, with either small or no drums, and with automatically controlled forced circulation, for which operating results will shortly be available. A further, if more remote, subject for research is the invention of some new organ or means of propulsion which would render the use of reduction gearing unnecessary. Actual developments mark the lines of possible further progress, but the time is now ripe for the embodiment of the ideas developed in Mr. Johnson's lecture in a large passenger liner. We trust that it will not be too long before a new "Empress of Britain" is built, which in her hull and machinery design will embody the most recent boiler and turbine practice, and will incorporate his interesting suggestions for the recovery of heat from the flue gases, giving a ship without funnels, and with cleaner and more roomy deck spaces. The lecture is to be delivered in our leading shipbuilding and engineering centres, and we do not doubt that it will inspire steam engineers to further effort along the lines indicated.

Literature.

Factory Organisation and Administration. By H. DIEMER. McGraw-Hill Book Company, Ltd., London. 1935. Fifth edition. Price 24s. net.

THE subject of the efficient organisation of a factory has been so much to the fore in recent years that development and change have taken place rapidly, and it is not surprising that when it was decided to publish a new edition of a book that was brought up to date in 1925, the author found it necessary to rewrite a large portion, to amplify in certain directions, and to curtail in others, so that the work we have before us is virtually a new production.

It is obvious that the field covered is so wide—embracing, as it does, the different spheres of management and organisation, including design, planning, stores and store-keeping, *personnel* work, &c.—that no individual sphere can be handled exhaustively; but the author has done enough to direct the thoughts of the reader, be he student or manager, along logical lines, and to unfold a definite scheme which could be applied to, or adapted to suit, any factory.

The sequence of chapters has been altered considerably in order to facilitate consistent and intelligent study, and this change is definitely an improvement.

We notice with regret that the last chapter of the fourth edition—a bibliography of works management—has been omitted, while, to make matters worse, the useful references to other authorities which formerly appeared at the end of each chapter are now missing. In a book that covers so wide a field, suggestions as to where more exhaustive development of each function may be found are invaluable.

Greater prominence has been given to the planning and control of each division of the factory, and the co-ordination of these controls in general administration.

But perhaps the most interesting feature lies in the consideration of management as a profession, indicating, as it does, that the days of the rule-of-thumb manager, who merely drifted into his post, have passed for ever. If in this country we have not advanced as far as the Americans, with their Association of Consulting Management Engineers, maintaining its definite code of ethics and professional conduct, we can at least benefit by a consideration of the manner in which the subject is approached on the other side of the Atlantic. We shall not quarrel with Mr. Diemer when he states that in the selection of a manager "a weight of about 80 per cent. should be put on personality, and 20 per cent. on knowledge." Perhaps even the 20 per cent. might be divided into two equal parts, one knowledge, and the other common sense. Happy, indeed, is the employer who finds the man possessing, in addition to this 20 per cent., "cheerfulness, health, neatness, confidence, enthusiasm, courage, honesty, self-respect, tact, poise, responsibility, industry, punctuality, and loyalty." We confess we have yet to meet this 100 per center!

While it is easy to criticise a book that covers so wide a field, we may perhaps be pardoned making reference to some notable omissions, and it is surprising that the estimating department does not receive full consideration. In a modern engineering factory—and particularly one manufacturing a diversity of products—an efficient estimating department is so essential that we should have welcomed Mr. Diemer's views on the question. He rightly stresses the importance of interlocking the cost accounts with the financial accounts, but it is also most desirable for cost accounting and estimating to be closely co-ordinated. A scheme whereby the manager can compare the actual cost of work with that of the estimate, particularly before it is too late, is a great asset to him.

We should like to have seen a more extensive use of charts advocated, for while the author describes the Gantt chart and its method of application fairly fully, he does not pay attention to the many other and simpler graphical aids to production which can be appreciated by the lowest intelligence. The simple bar chart has an extensive field of service in many works. Again, a system of following, in the production office, the progress of an order by means of discs which are moved from peg to peg by the progress man (a scheme which can be applied to stores and other activities) deserves at least mention. The use of colours for different operations when displayed on a progress chart speaks to all who see them in a very convincing manner.

We specially commend for consideration the chapter on Financial Control, and particularly the remarks bearing on budgetary control, a phase of factory organisation that has not received, at least in this country, the amount of attention it deserves.

We are fully in agreement with the views expressed on the subject of executive reports, for too often responsible foremen, and frequently the manager as well, lack the power to write concisely, and even to appreciate fully the object of the report. In these days of general education it is deplorable that so few are able to produce the ideal report, and rather seem to seek to hide its salient points in worthless verbosity. Those who have had the misfortune to be compelled to read many reports will welcome the remarks of Mr. Diemer.

Much food for thought is contained in the chart on page 9, which suggests the line of possible promotion in a typical manufacturing industry, the author being bold enough to indicate at the side the average earnings of the different grades, although he does not indicate the period! We find ourselves wondering if under modern conditions it is possible for a shop clerk to rise to be president (or general manager) of the concern. The chart is also interesting as showing the different employees that the author places in the same salary scale. It is difficult to agree with all the suggested values.

There is a temptation to discuss every chapter, for the subject is a fascinating one, naturally written from the American standpoint; but this should make it none the less valuable in this country; indeed, for many reasons, it will be beneficial for British engineers to make a close study of this work even if they may not be prepared to go to the full length advocated by the author. We have not yet reached the stage of asking those who seek employment a large number of impertinent questions, nor do we appraise them as a farmer does his cattle.

Fans. By THEODORE BAUMEISTER, JUN. London: The McGraw-Hill Publishing Company, Ltd. 1935. Price 21s. net.

FOR some unexplained reason the mechanical engineering of fans, like the cognate subject of centrifugal pumps, has never attracted potential writers of text-books to an extent at all commensurate with its industrial importance. Even in the transactions of technical institutions there is a paucity of papers on fan design and operation—a circumstance which may, in part, account for the lack of text-books. The present treatise is likely therefore to be generally welcomed by British readers, even though its illustrations and examples are taken almost exclusively from American practice. It does not purport to educate the professional designer, although the chapter devoted to theory is the longest in the book, but concentrates on what is probably the more useful purpose of aiding the user to select fans suitable to his particular needs, and to operate them with understanding. At the same time, while more practical in outlook than the average class text-book, it covers the elements of the subject in sufficient detail to satisfy the requirements of students, especially those interested in the functional considerations affecting design.

A feature of interest is the application to fans of the specific speed criterion more commonly associated with centrifugal pumps. As the author points out, this is a fundamental expression applicable, with suitable units, to any centrifugal machine, and can be employed with advantage in selecting the type of fan most appropriate to a given duty. It has the additional merit of showing at a glance which of two or more types is likely to give the most satisfactory performance in the event of a subsequent variation in the duty—a matter of some practical importance, though it appears not to be mentioned. For example, the book contains a diagram showing a number of static efficiency curves for different types of fan, plotted on a common base of specific speed. The graphs indicate that an efficiency of 60 per cent. could be obtained at a specific speed of about 1800 with either forward-curved or backward-curved vanes. If, however, the fan normally operated at less than the designed rating, forward-curving vanes would have a superiority in efficiency which might amount to 7 per cent., compared with the performance of backward-curved vanes, for a relatively moderate alteration in revolutions or quantity, but under conditions of a continuous overload of no more than 10 per cent., the exact opposite would hold.

Some thirty pages are devoted to fluid flow and the design of ducting, and a chapter on fan testing, of equal length, usefully includes the standard test code jointly sponsored by the National Association of Fan Manufacturers and the American Society of Heating and Ventilating Engineers, in co-operation with the Power Test Code Committee of the American Society of Mechanical Engineers. The book concludes with a chapter on propeller fans, described by the author as "probably the most important recent contribution to the fan art," which summarises much experimental research, but assumes rather too readily perhaps that the reader has convenient access to the sources of information enumerated. Most are available in the larger technical libraries, but these are not always accessible to the fan user, to whom the book is primarily addressed. The majority of readers, however, will probably find sufficient information in its pages, without requiring to consult the more specialised references following each chapter.

BOOKS RECEIVED.

The Book of Speed. Revised edition. London: B. T. Batsford, Ltd., 15, North Audley-street, W.1. Price 5s. net.

Gas Meters. Third edition. By A. T. Gilbert. London: Technical Press, Ltd., 5, Ave Maria-lane, E.C.4. Price 8s. 6d. net.

Outline Notes on Telephone Transmission Theory. By W. T. Palmer, B.Sc. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, W.C.2. Price 4s. net.

Plane and Spherical Trigonometry. By L. M. Kells, Ph.D., W. F. Kern, and J. R. Bland. London: McGraw Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 15s. net.

Practical Shop Mathematics. Volume 1, *Elementary.* By J. H. Wolfe and E. R. Phelps, Ph.D. London: McGraw Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 12s. net.

Hutchinson's Technical and Scientific Encyclopædia. Volumes 2, 3, and 4. Edited by C. F. Tureny and I. P. Shershov, A.M.I.E.E. London: Hutchinson and Co. (Publishers), Ltd., Paternoster House, E.C.4. Price £5 net the four volumes.

Chromium Plating: with Special Reference to its Use in the Automobile Industry. By Prof. Dr.-Ing. D. Bauer, Prof. H. Arndt, and Dr.-Ing. W. Krause; translated by E. W. Parker. London: Edward Arnold and Co., Ltd., 41, Maddox-street, W.1. Price 25s. net.

British Railways in 1935.

THE annual reports for the year 1934 showed that the four main line companies proposed to spend during the year £2,264,000 from capital on lines open for traffic. That amount was made up of the following sums :—L.M.S., £960,000 ; L.N.E., £346,000 ; G.W., £183,000 ; Southern, £775,000.

The following progress is now reported :—

London, Midland and Scottish Railway.

Works, Previously Mentioned, Completed.—The new station, Elm Park, between Dagenham and Hornchurch, was opened on May 18th. The sidings at Willesden, used for the cleaning, gassing, &c., of coaching stock, have been lengthened. The "new" viaduct at Sharnbrook—although opened in 1879 it is known as "new" because it parallels the original bridge of the Leicester and Bedford main line of 1857—has had its floor replaced by a new steel one welded to the top flanges of the existing main girders. A year ago we reported the completion of five of the nine spans, and the remainder were finished during the year. The new laboratory, of the research department, at Derby, was opened on December 10th. Forty-eight bridges, on various parts of the system, required to be strengthened in order to permit of the running of heavier engines on certain routes. A year ago we mentioned that forty-seven had been completed and that the contract for the last one had been let. The whole work is now finished. The modernisation of locomotive running sheds, in order to allow for the quicker turn round of the engines and for their consequent increased employment in traffic, made further progress during the year, and twelve further sheds were dealt with.

Works, Previously Mentioned, Progressing.—The rebuilding of the station frontage at Wembley is now complete. The strengthening of thirteen bridges on the Mangotsfield and Bath section of the former Midland Railway was mentioned in our review for 1934. Work on seven was completed last year.

New Works Begun and Progressing.—The sleeper depôts at Ditton, on the former L. and N.W., and at Beeston, on the old Midland, are being modernised to meet the increased requirements. At Wyre Dock, Fleetwood, new coaling plant for bunkering trawlers is being installed, together with additional siding accommodation and the substitution of electrical power for the existing hydraulic plant. The Queen's Hotel, at Leeds, is being rebuilt and modernised. A new approach road to the Wellington Station—which is to be remodelled—is in course of construction. A new block of offices, which, in addition to housing the company's own staff, which at present occupies offices on and around Wellington Station, will accommodate the L.M.S. and L.N.E. joint staff, is under construction. The south pier at Ayr requires extensive repairs. It is being provided with concrete piers, together with reinforced concrete piles, driven along the front of the pier, the space behind being filled with mass concrete.

London and North-Eastern Railway.

Works, Previously Mentioned, Completed.—The work of remodelling and improving Fenchurch-street Station was completed in May. The extensive alterations enable the railway companies using that station to run a large number of additional trains during the hours of peak traffic and to accelerate the train service. The principal features of the improvements inside the station are the more open concourse, or circulating area, and the improved and enlarged waiting-rooms, lavatories, and refreshment rooms. The very considerable permanent way alterations extending from Fenchurch-street to Leman-street, a distance of about one mile, involving re-siting of platforms, reconstruction of parts of the brick viaduct and reconstruction and strengthening of bridges, formed, however, by far the greater part of the work undertaken. A new subway, which gives access from John-street to all platforms, has been constructed. This entrance has its own booking office, lavatory accommodation, and bookstall. In connection with this work the company has installed electrically operated colour-light signalling in place of the mechanically operated semaphore signalling, together with electrically worked point-operating gear.

The new marshalling yard on the down side of the line, between Dinting and Mottram, of which the main features were related by us a year ago, was opened on October 28th. Water-softening plant has been provided at seven locomotive depôts and similar facilities are now being furnished to four other sheds. Electrically operated mechanical coaling plants have been provided at Boston and Norwich, and Annesley and Woodford sheds are being equipped likewise.

It was found desirable to improve the circulating area at Harrogate, and to do away with the antique type of booking-office. The booking and inquiry office has been rebuilt with "Hoptonwood" stone surrounds, oak framing, and "Staybright" sashes. Bridge No. 59, near Wormald-green, on the Harrogate-Thirsk line, carries the railway over the Harrogate-Ripon main road. It has been reconstructed to permit the highway to be widened from 36ft. to 65ft. The work was carried out in nine months' time. The bridge carrying the same line over the river Swale at Topcliffe, constructed in 1847, was a cast iron, six-rib arch bridge, supporting a double-deck ballasted timber floor, of 102ft. clear span. The structure has been replaced by a steel spandril arch bridge, supporting an open timbered deck, four-arch ribs being placed immediately under the rails. The erection was carried out without interruption of traffic, one-half of the bridge being closed, by removing the old and erecting the new ribs by means of breakdown cranes placed on the abutments. The weight of the cast iron in the old ribs was 210 tons, and the weight of the steel in the new ribs is 100 tons.

A similar type of booking and inquiry office to that at Harrogate, mentioned above, has been introduced at York. With a view to centralising the collection of tickets a passimeter booking-office has been erected at Selby. The new inward marshalling yard on the north side of the Priory Main yard at Hull, mentioned herein a year ago, was brought into use on December 9th. The roof, of three bays, and 330ft. by 165ft., of the Dairycoats engine shed at Hull, has been reconstructed in steel, with protected roof sheeting and glazed skylights. The final section of the reconstruction, refurnishing, and redecoration of the Royal Station Hotel, Hull, was completed during the year. For the same reasons that led, as already said, to the provision of a passimeter booking-office at Harrogate, one has been erected at Bank Top Station, Darlington. In order to permit the Whitby trains at Scarborough to remain at the platform during the interval between their arrival and departure, instead of having first to shunt out on to the main line, No. 1 platform was extended by 310ft. That necessitated considerable alterations in the permanent way.

New Works Begun and Still in Progress.—Leeds New Station, which adjoins the L.M.S. Wellington Station, is being resignalled. The work includes the installation of complete colour-light signalling, &c., at both the east and west ends of the stations. At the east end the points will continue to be worked mechanically, but a control panel will be provided for all signals, and all the indications will be incorporated therein. At the west end all points will be worked by electro-pneumatic power. A panel will be installed in a new signal-box to be called Leeds West, which will control the whole of the area at present worked from Station West and Canal boxes. The colour-light signals will be of the single-unit type, and the subsidiary signals will be of the position white light type throughout the area.

The North engine shed at York is being extended, and the former 60ft. engine turntable replaced by one of 70ft. diameter. This extension also furnishes sufficient space for the repair equipment to be placed in the shed. The resignalling of Waverley West signal-box at Edinburgh has been in hand for about two months, and will be completed sometime during the coming year. It includes the provision of an all-electric locking frame with 230 levers, D.C. point machines and detectors, colour-light running signals, banner type shunt signals, S.G.E. blind type route indicators, together with the necessary A.C. control relays, train describers, and power plant. The track circuit will be A.C., condenser fed, throughout.

Great Western Railway.

Works, Previously Mentioned, Completed.—The improvements outside Bristol Station, in connection with the reconstruction of Temple Meads Station to nearly three times its original size, may be reported as practically completed. An original lighting scheme has been installed in the main passenger subway, the fittings being of special prismatic design, which not only illuminate the subway but give a spot-lighting effect to the advertisement posters on both sides of the subway. A special type of gas lamp is employed for lighting the platforms.

Works Begun and Completed.—The first instalment of the alterations at Old Oak Common, which are to give greater facilities for the reception, re-forming, and dispatch of trains, is almost finished. The creosoting and chairing depôt at Hayes has been remodelled. It can now deal with an output of half a million sleepers a year (see THE ENGINEER, December 6th). The area will accommodate three-quarters of a million sleepers, in addition to a large quantity of timber for use in crossing work. Two new cylinders, which are each 90ft. long and 6ft. 9in. in diameter, have a capacity for 600 sleepers each, and can be worked at pressures up to 200 lb. per square inch.

The original Millbay Pier at Plymouth was built in 1849, and consisted of a masonry breakwater on a rubble bank, with a masonry roundhead on the sea end. It was extended in 1905, and a mass concrete pierhead built, with a timber jetty on the north side. Deterioration, due to the action of sea shrimps (*Limnoria*) led to complete rebuilding of the timber portion being considered necessary. The type of construction now carried out is pre-cast concrete to Ordnance Datum, with concrete cast *in situ* above that level. Two forms of construction were used—at the seaward end a double row of piles was driven, on which was seated a pre-cast "A" frame with a pre-cast raking strut to the old pier wall ; whilst the remaining portion of the pier is a single row of piles with a pre-cast raking strut.

A new bridge over the river Cleddau at Haverfordwest affords a good example of a balanced bascule, one of the simplest in principle and operation of the movable types. The old bridge, a six-span structure, with spans varying from 24ft. 6in. to 28ft. 2in., designed by Brunel, had its main carrying and cross girders of wrought iron ; the supports were timber piles heavily braced together. The new structure consists of three spans. The piers, of steel cylinders, 6ft. diameter, were sunk about 13ft. below the river bed to solid rock, and filled with concrete. The bascules are operated by hand winches, accommodated on a platform under the main girders, and worked by heavy chains running over pulleys. Each leaf can be opened in about ten minutes.

Southern Railway.

Works, Previously Mentioned, Completed.—Under this heading is the improvement of the stations at Raynes Park, Worcester Park, and Cosham ; the new locomotive depôt at Norwood Junction, and the water-softening plant at Ewer-street. The enlargement of Southampton West Station—now known as Southampton Central—and the widening of the line between that station and Millbrook, including a reconstructed station at the latter place, was completed during the year. The enlargement and remodelling of Bricklayers' Arms Station, so that it may be used as a Customs depôt when the train ferry to the Continent is in operation, is another undertaking that was completed.

Works, Previously Mentioned, Still Progressing.—The main item to be noted is the construction of the dock at Dover to form a berth for the Dover-Dunkerque train ferries. It is proceeding.

Works Begun and Progressing.—The line between Waterloo and Hampton Court Junction is being resignalled with colour lights. To provide for a more convenient approach to, and departure from, Waterloo the lines are to be rearranged, in which connection a flying junction is to be erected on the east side of Wimbledon.

Work has been begun on a large scheme of alterations at Nine Elms Goods Station, which includes, among other items, the construction of a six-storey granary and the provision of six electrically operated portal cranes. The stations at Richmond, Surbiton, and Woking are to be completely reconstructed, and improvements are in progress at Peckham Rye, Reedham Halt, Worcester Park, Feltham, and Brockenhurst.

During the year the lines to Eastbourne, Bexhill, and Hastings were electrified, and the electrification to Sevenoaks was completed, as also the electrification of the branches from Lewisham to Nunhead and from Woodside to Sanderstead.

Works Begun and Completed.—Four additional intermediate stations were opened during the year, and an additional siding and platform was constructed at Redhill to accommodate the increasing mail traffic at that important postal depôt.

Electrification.—There is at present actively in hand the electrification of the following lines :—Hampton Court Junction to Woking, Guildford and Portsmouth ; Weybridge to Chertsey and Staines ; and Woking to Farnham.

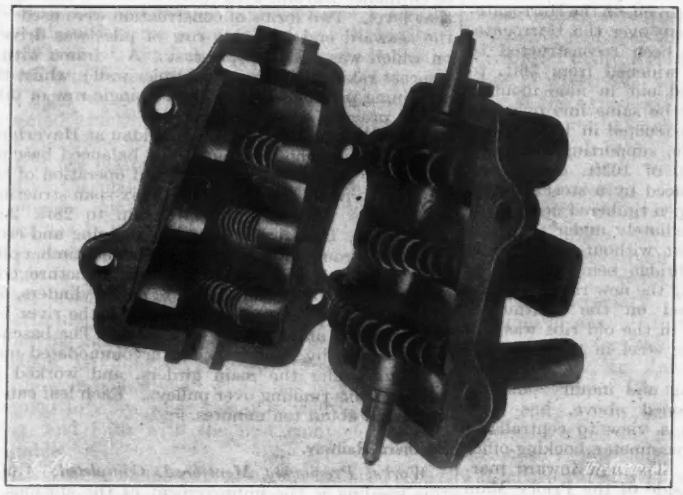
MANUFACTURE OF SHEET STEELS IN CANADA.

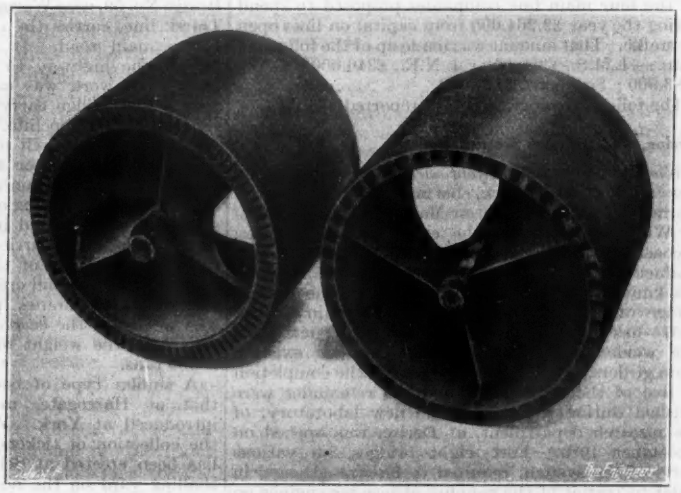
AN important programme of expansion is nearing completion at the plant of Dominion Foundries and Steel, Ltd., Hamilton, Ontario. The company is now employing 1020 men, and expects ultimately to employ more than 1500 as a result of the adoption of the cold reduction process for making sheet steels in coils. Expenditure on installing equipment for the new process will total more than 1,000,000 dollars. The Hamilton plant now spreads over 26 acres and is capable of producing 150,000 tons of rolled and cast steel products annually. The first tin-plate made in Canada complete from the raw material to the finished product (except imported tin not found in Canada), was recently made at the plant of Dominion Foundries and Steel, Ltd.

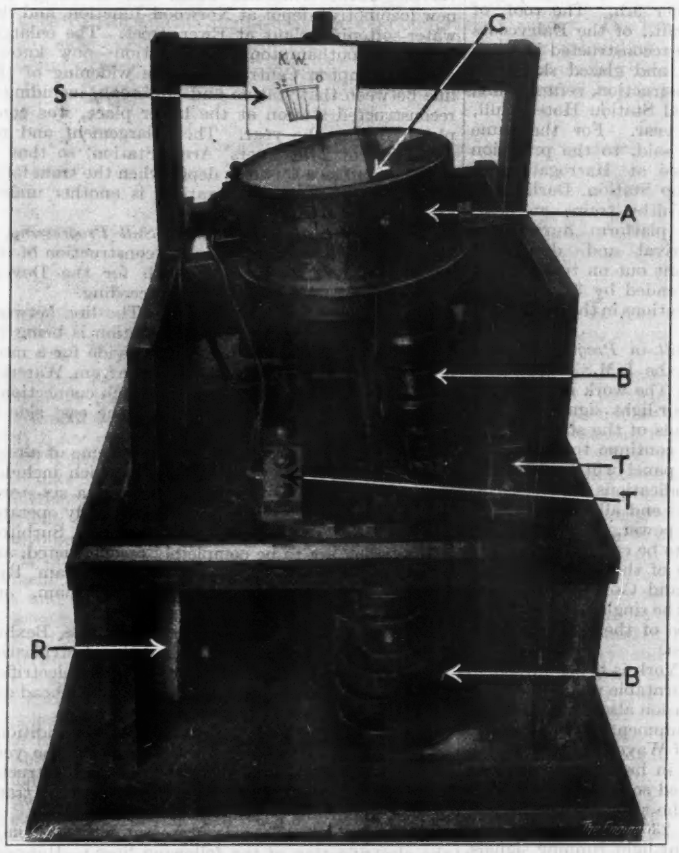
The cold rolled steel is made from hot rolled strip which the company already produces. The steel is uncoiled and is first drawn through pickling vats which clear all scale from the surface. This is a continuous operation, the front end of one coil being electrically welded to the rear end of another. The weld is cut out when the cleaning is finished and the steel is recoiled. The coil of steel, about 500ft. long and 0·100in. thick, is then passed in and out of the four-high cold rolling mill, and thus reduced to any desired gauge. A wider four-high cold rolling mill is now being built, and this will give a total capacity of about 600,000 boxes of black plate for tinning annually, or 100 tons of cold rolled steel daily.

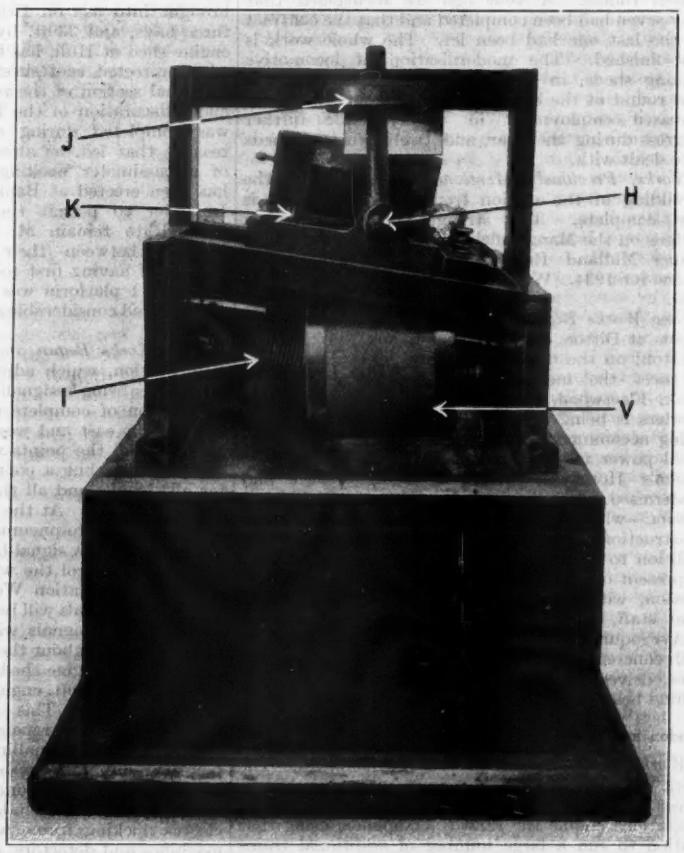
TURBINE AND METER CLOCK MODELS USED BY SIR CHARLES PARSONS

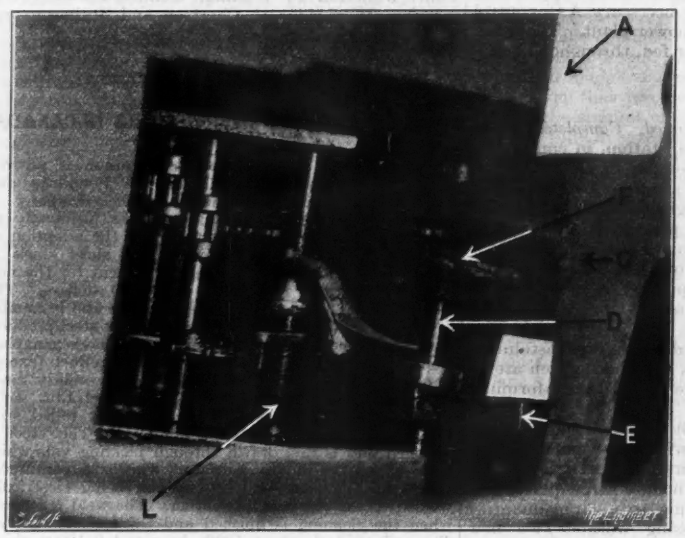
(*For description see opposite page.*)











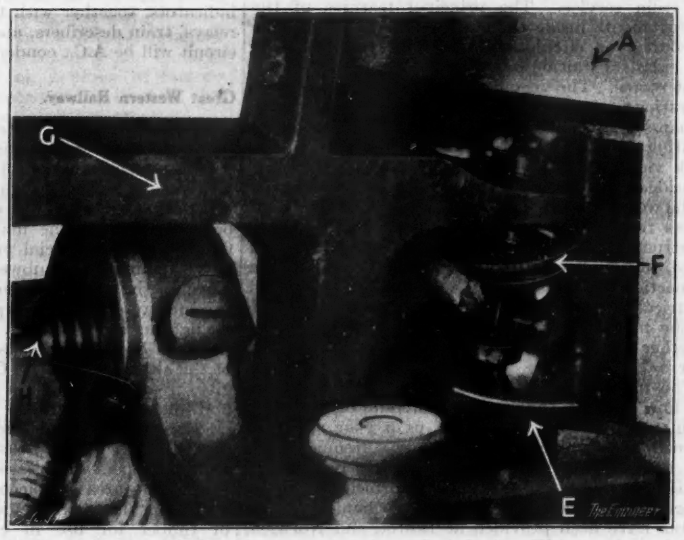


FIG. 1 (ABOVE)—MODEL OF WILSON TURBINE

FIG. 2 (ABOVE)—ALTERNATIVE WHEELS FOR MODEL SHIP

FIGS. 3, 4, 5 AND 6—CLOCK ENERGY METER: FRONT VIEW SHOWING DRIVING SPRINGS, REAR VIEW SHOWING POTENTIAL AND CURRENT COILS, THE ESCAPEMENT, AND THE BALANCE WEIGHT

Models Used by Sir Charles A. Parsons.*

DURING the recent demolition of the "Gramophone Shop," which was originally used by Sir Charles for experimental work, a number of interesting models were brought to light. These models, some of which pre-date Heaton Works, are of considerable interest, for it is well known that Sir Charles relied more upon experiment than upon calculation. The practice of making models goes back to his early days, when he used to make contrivances of cardboard, cotton reels, sealing wax, &c.

In a memoir by Lord Rayleigh, published in the "Scientific Papers and Addresses of the Hon. Sir Charles A. Parsons" (Cambridge University Press), reference to Sir Charles' reluctance to rely upon calculation is made in the following manner:—"It was, in fact, very curious how little use he [Sir Charles] ever seemed to make of the formal mathematical training he had had at Cambridge. He had been 11th Wrangler in the Mathematical Tripos, and must be credited with having had, at one time, a thorough mathematical knowledge and facility in using it. At the time I knew him, however, he never allowed this to appear. I do not think that I ever saw him use any mathematical method more complex than the rule of three."

In the same memoir Lord Rayleigh again makes reference to Sir Charles' leaning towards unorthodox methods when he says:—

"Although Parsons did not make use of any formal methods of calculation, he seemed to have a kind of subconscious way of arriving at conclusions for which most people would have found such methods indispensable. Needless to say, he could not explain how he did it—but then he equally failed to explain with any lucidity things which, to the ordinary observer, were much less mysterious."

A number of interesting models have already been placed in the Memorial Room at Heaton Works, but in the present article we are mainly concerned with the models which have more recently been unearthed. The more important of these we propose describing, namely—(*a*) a model of Wilson's turbine, (*b*) compressed air turbine driven ship model, (*c*) clock energy meter.

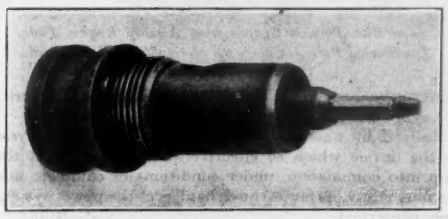


FIG. 8—DETAIL OF NON-RETURN VALVE

(*a*) WILSON'S TURBINE.

Before Sir Charles Parsons lodged his original patents in 1883–84, he had already given a great deal of thought and practical attention to small but essential working details of high-speed machinery. This attention to detail was probably one of the primary reasons for the immediate success of his compound steam turbine, and has, in fact, characterised the Parsons' turbine throughout its development.

On the other hand, while Sir Charles knew that many others had already been in the field, but had failed to produce a practical steam turbine, he did not conduct an exhaustive search into previous patents. Probably the reason for this was the difficulty of making such a search in those days, and its expense.

Addressing the Engineering Section of the British Association at Cambridge in 1904, Sir Charles said:—

"What a waste of time, expense, and disappointment would be avoided if we in England helped the patentee to find out easily what had been done previously, on the lines adopted by the United States and German patent offices, who advise the patentee after the receipt of his provisional specification of the chief anticipatory patents, dead or alive. . . . Ought not our Patent Office to give more facilities and assistance to the patentee? . . . In some cases the cost of a thorough search is very great indeed; sometimes it is greater than the cost of a trial attack on the problem. . . ." There had been, in fact, a great number of previous inventions relating to steam turbines and many unsuccessful patents had been taken out by various inventors during the nineteenth century. The ultimate complete success of the steam turbine aroused interest in these old patents, and they were resurrected and described in several books of reference.†

One of these anticipatory patents which came nearest to forestalling Sir Charles Parsons' invention was No. 12,026, granted to the Rev. R. Wilson, of Greenock, M.A. of Edinburgh, in 1848. This patent covered improvements relating to rotary engines, and was chiefly concerned with the successive expansion of steam. Several compound reaction turbines were described in which the steam flowed through alternating sets of stationary and rotating rings of blades, expanding gradually during its passage through them.

In a paper read by Sir Charles Parsons before the Greenock Philosophical Society, January 16th, 1909, and entitled "The Expansive Working of Steam in Steam Turbines," he referred to Wilson's turbine of 1848 as follows:—

"The principles of Wilson's designs are generally correct, but the proportions of his turbine are extravagantly incorrect, the blades being too large and too few for success. I had a model made of Wilson's turbine eighteen years ago (1891), and under steam all that could be said was that it went round the right way. I do not think that Wilson could have made a model and tested it before he applied for his patent."

Fig. 1 shows a photograph of the model of a Wilson turbine which was recently unearthed at Heaton Works, and which is probably the model to which Sir Charles was referring.

(*b*) COMPRESSED AIR TURBINE DRIVEN SHIP.

The problem of improving ship propulsion and ship forms must at one time have occupied the attention of Sir Charles, judging by the assortment of model ships which have been brought to light, and which were made probably while he was at Messrs. Kitsons at Leeds. One of these, which is of considerable interest, defied explanation until one of two steel tubes comprising part of the equipment was cut open to enable the interior to be inspected. These tubes proved to be compressed air or gas cylinders, which could be charged with gas, escape being prevented by valves similar to those fitted to modern motor car tires (Fig. 8).

The main feature of this experiment is the novel combination of the turbine and propeller into one single unit immersed in the water as an alternative form of drive to the standard arrangement of turbine inside the hull and the propeller outside.

The charge used could be either high-pressure air or possibly some form of slow-burning gunpowder producing gases. When the charged cylinders were screwed inside the hull of the ship a small projection released the non-return valve in each cylinder (just as a Schrader type of valve is released by pushing gently on the top of the valve spindle), thus allowing the air to flow into a common pipe leading through a hand-controlled valve to the turbine. Fig. 9 gives a view inside the hull showing the projections for the air cylinders. The ship is shown in Fig. 7, and for the purpose of this description parts have been lettered for reference.

The valve A shown in Fig. 7 controlled the escape of the air from the pipe to the turbine wheel. This valve was operated by hand externally, and enabled the ship to be started when required. The air discharged through a small jet B on the underside of the hull on to the moving blades in the turbine wheel. A detail of the wheel is shown in Fig. 2, and it will be seen that it comprises a bladed portion on the outer edge, with the propeller inside.

Two alternative wheels have been found, with different blade heights, and screw pitch, but no record exists describing the results obtained.

(*c*) CLOCK ENERGY METER.

The principle of metering electrical energy by controlling the rate of going of a clock was proposed originally by Ayrton and Perry in about 1882.

In their instrument the oscillation rate of a pendulum in a clock was controlled electro-magnetically by the load which was to be measured.

A pendulum carrying a coil of fine wire with its plane horizontal and connected across the mains, when acted upon by a coil carrying a current located immediately below, experiences an attraction which is proportional to the current strengths in the two coils. Thus the pendulum will be accelerated proportionately to the load and the rate of gaining of the clock can be calibrated against a standard clock to read the product of kilowatt-hours.

It would appear that Sir Charles became interested in this field of development, as the photographs reproduced in Figs. 3, 4, 5 and 6 will show. The instrument depicted is now in the Heaton Works Museum, but as nothing appears to be known of its history, we can only point out the ingenious construction and surmise the mode of operation of the meter. Whether patents were taken out and instruments were ever made and sold lies buried in the past.

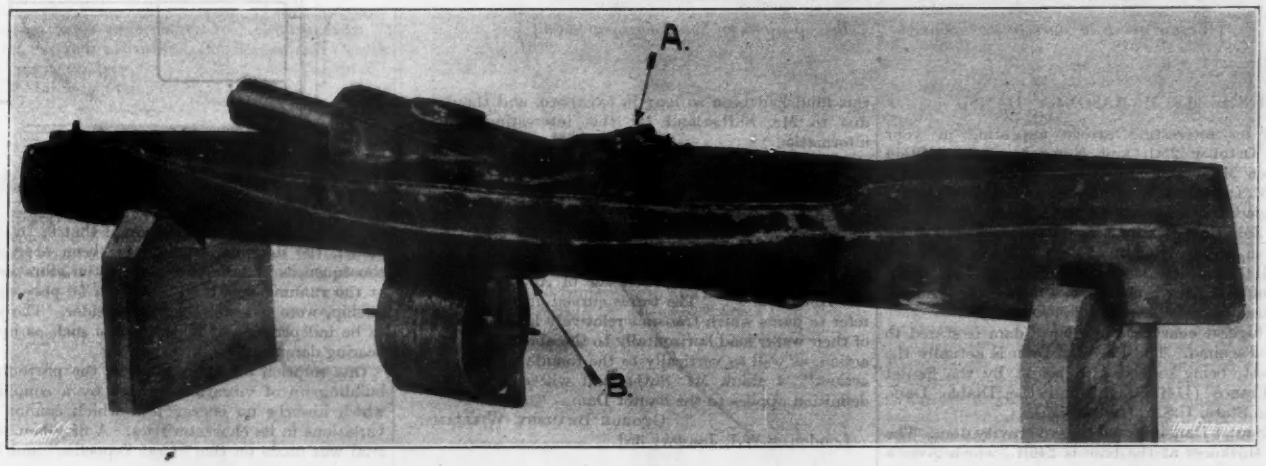


FIG. 7—MODEL SHIP DRIVEN BY A COMBINATION OF TURBINE AND PROPELLER IN A SINGLE UNIT

The meter consists essentially of a clock of the cheap American alarum pattern A. The alarm and springs have been removed, and in their place six springs in tandem B are connected to the alarm winding mechanism. Both sets of springs are geared together within the clock to produce a strong driving force with an equivalent eight-day operation with one winding, when the clock is operating at normal speed. A star-wheel device C operated by a projection on the hour hand is provided on the clock face to indicate the number of complete revolutions of the hour hand.

The balance wheel of the clock has been removed. The escapement is arranged to operate a modified form of balance wheel with a hair-spring F, but having a weight E in place of the usual wheel. The weight is pivoted about an axis mounted vertically in pivots carried by a brass bracket G, which is, in turn, pivoted at H on knife-edges. Fixed at right angles to the bracket and below the centre line of the pivots H is a tubular former V carrying a number of turns on fine wire. Inside the former is a fixed coil I carrying several turns of heavy gauge wire. The coil V can move in an arc with a centre on the axis H H. The coil V, which is the potential coil, is connected by flexible leads through a resistance R to the supply from the terminals T. The coil I, which is the current coil, carries the main load current to be measured. There is therefore an attraction between the two coils, and the coil V is pulled away from its zero position by an amount depending on the load current, the restoring force being gravity. Weights J and K are for adjusting the sensitivity.

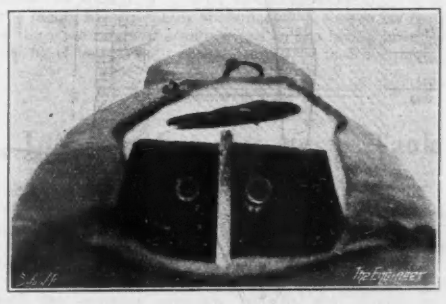


FIG. 9—VIEW INSIDE HULL OF SHIP

The movement of the coil from the vertical sets the balance weight axis D out of the vertical by the same amount. When the axis D is vertical, *i.e.*, when no load is being taken from the mains, the balance weight E of the clock oscillates in a horizontal plane, being controlled only by the spring F, gravity having no effect on the weight. The clock operates therefore in the normal manner and keeps standard time.

When V is deflected by the load current, the shaft D becomes out of the vertical and the oscillation of the weight E is now influenced by gravity acting in conjunction with the hair-spring F. The periodic time of oscillation of E is increased therefore and the clock will gain, the amount

* By permission, from the *Heaton Works Journal*, December, 1935.

† "Steam Turbines," by Lester G. French (Hill Publishing Company, 1907); "Barkers Mills to Turbines," by W. J. Harding (published by G. W. Wood, 1911). "The Steam Turbine," R. M. Nielson (published by Longmans, Green, 1912).

of gain being dependent on the angle which D is from the vertical, which, in turn, depends on the load being measured. The greater the load, the faster will the clock run.

It will be noticed that the clock A is set at an angle of some 10 deg. to the horizontal. This is done so that the maximum angle between the fixed escapement L and the spindle D is only ±10 deg. instead of +20 deg. from normal.

Fixed to the bracket G is a pointer moving over a scale S, which may be calibrated in kilowatts.

In conclusion, the essential difference between this instrument and that devised by Ayrton and Perry is the method of controlling the rate of gaining of the clock by the load current.

In the former case the effect of gravity on the clock balance wheel is increased in proportion to the load, so speeding up the clock with load; where in the latter case the rate of swing of a pendulum is increased by the load current assisting gravity, the force being again proportional to the load.

It is interesting to record that when some of the dust was removed and the clock oiled, the instrument operated satisfactorily.

Mr. Gerald Stoney has added the following notes about the clock energy meter:—"Somewhere about 1893 I was experimenting for Sir Charles on meters of this type, and I think that this may be one of them. In those days one of the principal meters was the Aron, in which there were two pendulums, one acted on by the current. Sir Charles' idea was to have a balance wheel which was put out of balance and inclined by the current, and thus the rate of the clock altered. In the one described, the balance wheel was moved; in another, the whole clock, but this did not work as the C of G of the clock altered as the spring unwound. These worked either A.C. or D.C.

"Another type of meter was one in which there were two thermopyles, one warmed and the other cooled by the current. In each of them was the leg of a U tube, sealed, and filled with a volatile liquid. This evaporated from one leg to the other, and thus gave a measure of the current passed."

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

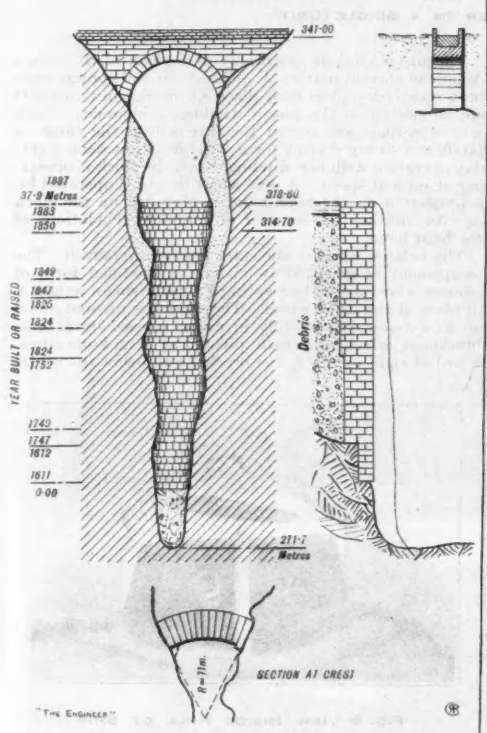
SINGLE-ARCH MASONRY DAMS.

SIR,—In an interesting article appearing in your issues for October 25th and November 8th, entitled "Single-arch Masonry Dams," by Mr. George Bransby Williams, M. Inst. C.E., the following errors occur, and I should be glad if you would correct them:

(1) The Zola dam is stated to be the first arch dam. This is not so, as the arch dam at Ponte Alto, in Italy, was built in 1611, or about 230 years before the Zola Dam. A sketch of this dam is enclosed, taken from "Annali delle Utilizzazioni delle Acque," Vol. I, 1924.

(2) The highest constant angle arch dam is stated to be that at Pacoima. The Pacoima Dam is actually the third highest, being exceeded in height by the Sautet Dam in France (414ft. high) and the Diablo Dam, Washington State, U.S.A. (400ft. high).

(3) The Sautet Dam is stated to be a gravity dam. The maximum thickness at the base is 246ft., which gives a



The Ponte Alto Arch Dam.

ratio of base to height of only 0·59, insufficient for a true gravity dam. In the construction of the dam, the downstream portion was made of a lean concrete, and is intended to act mainly as a support to the sides of the gorge. The upstream portion is a true arch, being made of a richer concrete and having the abutments excavated out to radial planes to take the thrust of the arch. The higher modulus of elasticity of the arch portion will ensure that a large portion of the load is taken by it, although undoubtedly some support will be given by the backing.

ROBERT A. SUTHERLAND, A.M. Inst. C.E.

Berkeley, California, December 18th, 1935.

SIR,—From Mr. Sutherland's drawing of the Ponte Alto dam it appears that it is situated in a deep and narrow cleft in the rock. In such a position the idea of arching it would be likely to occur to the builder. This consideration does not deprive the seventeenth century Italian engineer responsible of the credit of having constructed the first dam arched in plan. It was news to me, and will be, I am sure, to most of your readers, that any dam of this kind had been so long in existence, and thanks are due to Mr. Sutherland for this interesting piece of information.

In referring to the Pacoima Dam as the highest constant angle dam, I was only considering the dams in America. I had overlooked the Diablo Dam, and am grateful to Mr. Sutherland for correcting my statement.

As regards the Sautet Dam, I described this as a curved gravity dam. In this connection I may quote from Mr. Ivan Houk's article in your issue of August 4th, 1933. Mr. Houk states: "The terms curved gravity dams . . . refer to dams which transmit relatively large proportions of their water load horizontally to the abutments by arch action, as well as vertically to the foundation by gravity action." I think Mr. Sutherland will agree that this definition applies to the Sautet Dam.

GEORGE BRANSBY WILLIAMS.

London, S.W.1, January 3rd.

THE BRITISH INSTITUTE OF PHILOSOPHY.

SIR,—Four years ago we sent a letter to the Press appealing for support of the British Institute of Philosophy, which was founded in 1925 with the late Lord Balfour as its first President. The appeal was based on the existing disorganisation of beliefs in fundamental principles in every department of life, and the need of a cultivation of systematic thought that has the most intimate bearing on practice. Since then this need has not diminished. We have seen in the interval the rise of forms of political life which appear to deny those constructive forces which have been generally regarded as of first importance. On this and on other accounts there is pressing need to consider what the primary standards of right and wrong in the conduct of nations should be.

We therefore, in the tenth year of the Institute, venture to ask for your hospitality with a view to making its work better known and obtaining further support that will enable it to extend its activities. These consist at present of the publication of the quarterly review *Philosophy*, the holding of courses of public lectures, the organisation in London and other cities of reading circles, and the arrangement of monthly evening addresses by leaders of opinion in various departments of thought, scientific, æsthetic, political, moral, and religious. Those of your readers who would desire to become members of the Institute (the subscription is £1 1s., which covers the price of the quarterly review), or to obtain further information with regard to it, are invited to communicate with the Director of Studies at the Rooms of the Institute in University Hall, 14, Gordon-square, London, W.C.1.

S. ALEXANDER.
ARTHUR EDDINGTON.
WILLIAM EBOR.
W. R. INGE.
A. D. LINDSAY.
OLIVER LODGE.
J. H. MUIRHEAD.
RUSSELL.
RUTHERFORD.
HERBERT SAMUEL.

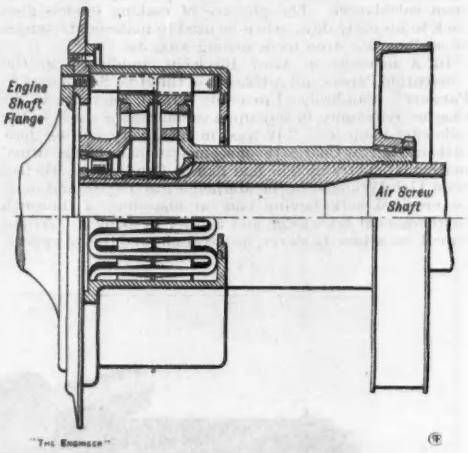
London, January 7th.

THE "GRAF ZEPPELIN."

SIR,—Considerable prominence has been given in your issues of December 20th and 27th in connection with Dr. Shannon's paper, to the failure of the crankshafts on the "Graf Zeppelin," due to torsional vibration, but no mention has been made of the remedy.

On returning to Friedrichshafen Bibby desynchronising couplings were fitted as shown on the drawing. The driving element was fixed to a flange on the crankshaft and the driven element, through a sleeve, to the airscrew. The shape of the grooves and spring section were such that when the plant entered a critical speed, the stiffness of the coupling was increased by 110 per cent., which automatically increased the frequency. The coupling was also arranged to displace the harmonic concerned, so that the running speed occurred in the hollow between the two criticals. The diagram shows the effect of altering the frequency and the reduction in amplitude at the critical. The running speed is shaded. The airship has since done over 600,000 miles and no alteration or replacement has been made to the couplings.

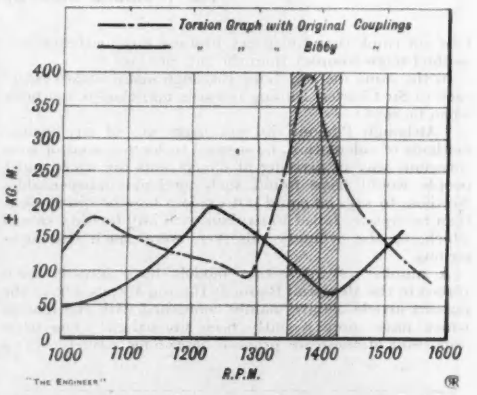
The suggestion that the disaster might have been prevented had plain bearings been used can hardly be seriously considered. There would have been no alteration in frequency, and, since the amplitude of the swing in



Bibby Couplings as Fitted on "Graf Zeppelin."

the bearings was only a fraction of that in Dr. Shannon's model, the damping would have been negligible. The consequences of failure to reduce the vibration torques, at the running speed, by less than 50 per cent., on the airship, were too appalling to consider. The safety had to be independent of all influences such as hypothetical bearing damping.

One solution of the problem is the prevention of the building up of vibration torques by a coupling system which absorbs no energy and which cannot have any variations in its characteristics. A fifty-hour exhaustive trial was made on the "Graf Zeppelin," and the results



Comparative Torsion Graphs from Airship Engine Tests. The Shaded Portion Covers the Normal Travelling Speed.

were so conclusive that she at once started her long series of voyages.

Full credit was given in the German technical Press to the device which so effectively and quickly put the ship into commission, under conditions of complete and obvious safety, as far as the dynamics of the power system were concerned.

J. BIBBY.

London, S.W.1, January 10th.

LOCOMOTIVES AND SMALL-SCALE TESTS.

SIR,—I read with great interest the letter on "Small-scale Tests" by "H. O. C." in THE ENGINEER of even date.

His opening remarks with regard to aeroplanes I cannot gainsay, as I have no interest in them. To my mind, from an engineering standpoint, they are "lesser things without the law."

The remarks which he makes in connection with locomotives, however, come within my province, and as one who may, with all due modesty, claim more than a nodding acquaintance with them, may I ask him—has he ever made a model locomotive?

I started off some years ago upon that pleasant task armed with a very well-fitted-out, for an amateur, workshop, and the knowledge acquired during an apprenticeship served in the works of one of our leading railway companies, and I found that I had to start learning all over again.

To obtain true results from a model one must have model conditions reproduced, which is impossible; in other words, you are not able to bring Nature down to the model stage.

One example will suffice. Take a locomotive boiler barrel with, say, 200 1¾in. tubes. Is it possible to produce this on a 1in. scale model? No; because you would block them all up with char as soon as the engine started work.

I have a very successful 1½in. scale narrow-gauge tank engine which I built which has eight ¼in. diameter fire tubes, 11in. long through barrel, and I find that it would still steam with three of them plugged up. How would the prototype perform under similar conditions ?

With reference to blast orifices, &c., the same applies. In the model which I mention I have a ⅜in. blast nozzle for two 1½in. bore cylinders, or as 4 to 1 in relation to cylinder bore. A modern 20in. cylinder engine would have about a 5in. or 4½in. nozzle, so that there is little difference on this point ; but consider the difference in the flow of steam through it when the engine is working.

I am prompted to write this letter because I was once of the same opinion as "H. O. C." with regard to this point, and it took me many years to disabuse myself of the idea. G. G. WOODCOCK.

Tottenham, January 10th.

TURBOMOTIVE !

SIR,—I hoped the word "turbomotive" had died a natural death, but I find it again in your issue of January 3rd, page 24. May I enter a protest against the introduction of this word ?

The word "locomotive" implies, I think, motion from place to place. Does "turbomotive" imply motion from turbine to turbine ? And if the word is permitted are we to proceed to "oleomotive," "Dieselmotive" and (confusion worse confounded) to "electromotive" ?

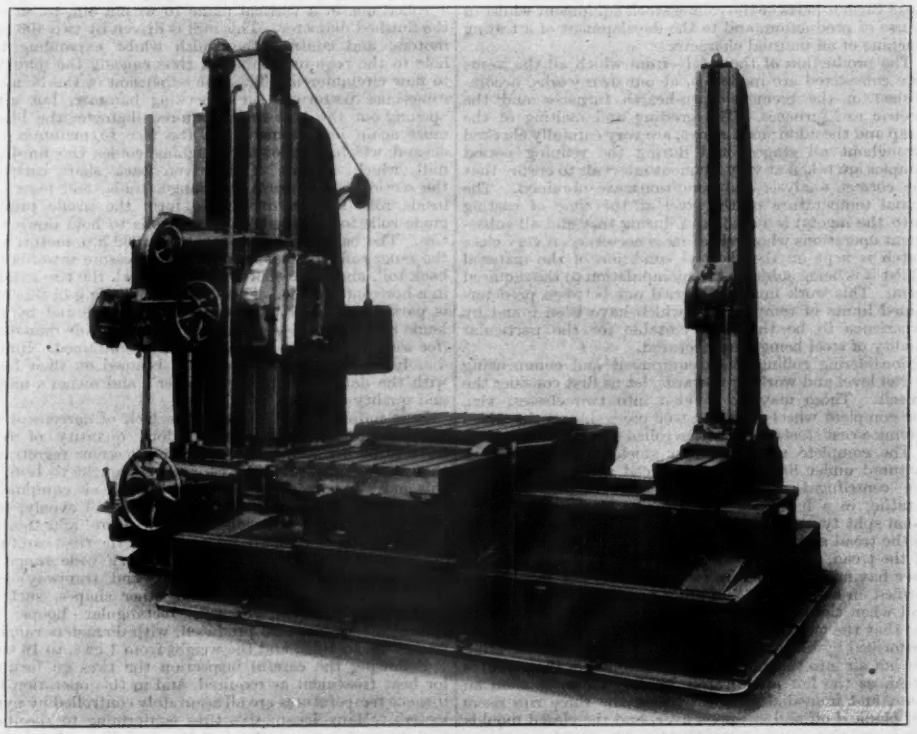
Please let us stick to turbine, oil, Diesel, and electric locomotive respectively. R. FYNES-CLINTON.

Liverpool, January 14th.

Two New Boring Machines.

WE illustrate below two new surfacing and boring machines which have recently been produced by George Richards and Co., Ltd., of Broadheath, near Manchester, for a rather special class of work, although they closely resemble the standard machines made by this company.

The idea is that in many general engineering shops



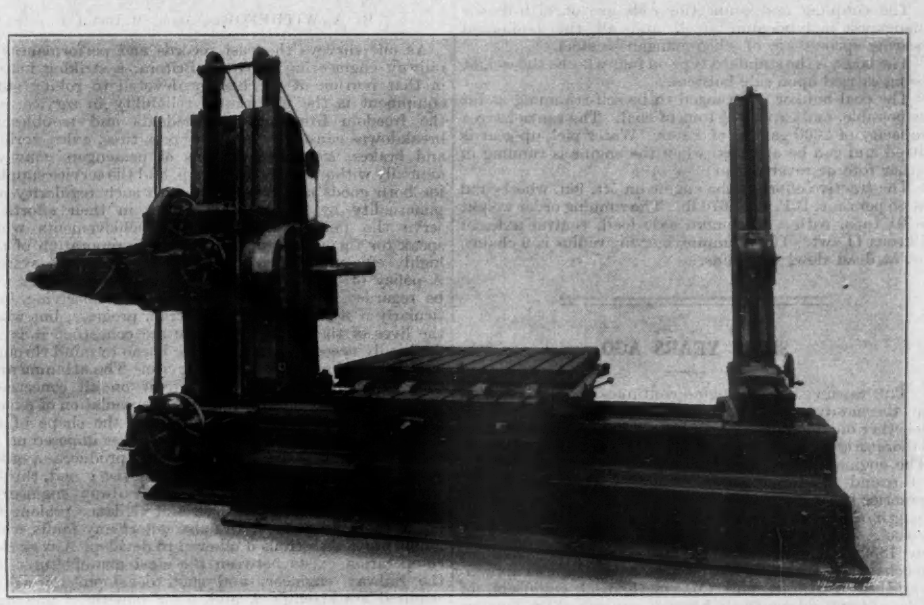
PLAIN BORING MACHINE

castings of ungainly shape and bulk have to be bored or faced, or both, but these operations are of a comparatively light character. With a normal equipment such a job entails monopolising a large and powerful machine to accommodate the casting, while the tools are capable of doing far more work than is required of them. The company has therefore brought out these new machines, which have large overall dimensions, with the equipment of a standard, smaller machine. They are also available for doing small jobs and consequently need not lie idle on account of their special design. The two machines are different in that one is intended primarily for facing, while the other has a traversing boring spindle.

The plain machine, which may be described as the standard type, has a bed 7ft. wide with slideways at the extreme edges to give additional support to the saddle when carrying heavy castings. In the centre there is the slide bed proper with two flat slides to guide the saddle. The main table measures 7ft. 8in. by 3ft. 2in., and has a 6ft. 8in. automatic cross traverse on the sliding saddle. On the top of it there is mounted a square revolving table measuring 3ft. 2in. each way. This table is fitted with a patented squaring lock which ensures a very high degree of accuracy between all four sides of a piece of work. The top table can be raised from the front of the machine and, together with a heavy load, can be turned round quite easily. The table has a longitudinal traverse along the bed of 70in., whilst the maximum distance between the boring bar socket on the facing slide and the boring stay is 8ft. 8in. The centre of the spindle can be adjusted above the top table from 5in. to 66in. and above the main table from 9in. to 70in.

The spindle frame and facing head are of standard proportions, the facing capacity being 36in. Eight reversible feeds are provided for the facing slide ranging from 0·02in. to 0·25in., and a similar number to the tables longitudinally and transversely, and to the spindle frame vertically, the range in the latter case being from 0·01in. to 0·125in. Rapid power traverses are also provided to the spindle frame vertically and to the table longitudinally and transversely.

The facing head has a total of twenty-four speeds, ranging from 2·58 to 220 r.p.m., and reversing motion is provided for convenience in tapping operations. The upright or column on this machine incorporates the makers' patented prismatic slide, which causes the cutting



TRAVERSING SPINDLE BORING MACHINE

force to be distributed over a large area and is of great value when the machine is used for intermittent cutting or heavy duty, ensuring not only steadiness, but also great accuracy. Rules and verniers are fitted to the longitudinal, transverse, and vertical movements, enabling adjustments to 0·001in. to be rapidly made. The machine has a direct motor drive by means of a 15 h.p. constant-speed motor, the transmission therefrom to the speed gear-box being made by silent spur gearing.

On the machine with traversing spindle shown in the second illustration, the bed is 5ft. 2in. wide overall, and also has extended wings having guideways on which slide the outer supports to the saddle. The main table of this machine is 7ft. 3in. by 4ft., having a 6ft. automatic cross traverse. The top or revolving table is 5ft. square, and is equipped in the same manner as that just described. The longitudinal traverse to the table along the bed is 72in., and the maximum distance between the facing slide and boring stay is 10ft. 9in. The traversing spindle is 3½in. diameter and has a total traverse of 5ft. The vertical adjustment is from 4½in. to 71½in. above the top table, and from 9½in. to 77in. above the sliding table. Here, again, the spindle frame and facing head are of standard proportions, the facing capacity in this machine being 42in. diameter.

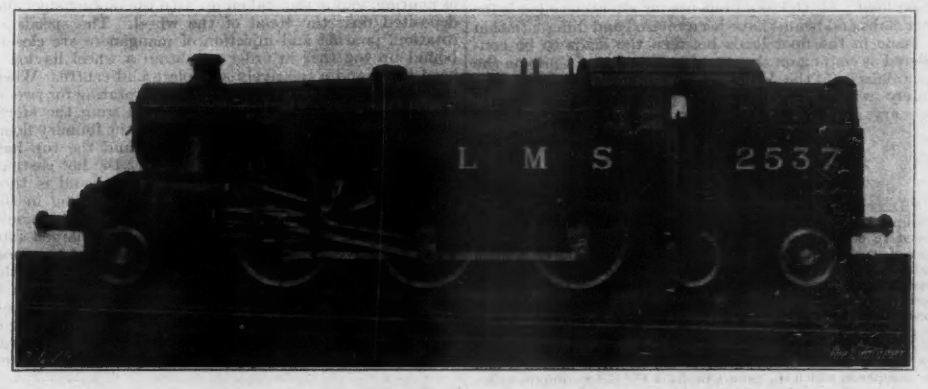
Eight reversible feeds are provided for the facing slide, ranging from 0·02in. to 0·25in., whilst eight feeds ranging from 0·01in. to 0·125in. are given to the table longitudinally and transversely, to the spindle frame vertically, and to the traversing spindle horizontally. A very wide range of speeds is provided both for the traversing spindle and for the facing head. A total of thirty-two speeds is given to the traversing spindle ranging from 2·58 to 250 r.p.m. Of these, the eight highest, *i.e.*, from 64 to 250 r.p.m., are independent speeds to the spindle, and when the spindle is running at any of these eight speeds, the facing head remains stationary. A particular feature is the wide range of speeds given to the facing head, consisting of twenty-four speeds from 2·58 to 220 r.p.m.

L.M.S. 2-6-4 Passenger Tank Engine.

EIGHT new two-cylinder 2–6–4 superheated tank engines (as illustrated) are under construction at Derby works to the designs of Mr. Stanier. They will be numbered 2537 to 2544 inclusive.

The boiler is one of the new standardised types, and the working pressure 200 lb. per square inch.

The superheater is designed to give a moderate degree of superheat, and comprises eighteen flue tubes arranged in three rows, with a surface of 185 square feet. The total



L.M.S. PASSENGER TANK ENGINE

evaporative surface is 1168 square feet and the grate area 25 square feet.

There are two cylinders, each 19⅝in. diameter by 26in. stroke, with piston valves having a long travel and actuated by Walschaerts gear.

The coupling and connecting-rods are of high-tensile manganese-molybdenum steel, and all the laminated bearing springs are of silico-manganese steel.

The bogie is the standard type on four wheels, the weight being carried upon side bolsters.

The coal bunker is arranged to be self-trimming as far as possible, and carries 3½ tons of coal. The tanks have a capacity of 2000 gallons of water. Water pick-up gear is fitted and can be operated when the engine is running in either fore or reverse gear.

The tractive effort of the engine on 5ft. 9in. wheels and at 85 per cent. B.P. is 24,670 lb. The running order weight is 91 tons, with a maximum axle load, central axle, of 19 tons 11 cwt. The minimum curving radius is 6 chains, or, at dead slow, 4½ chains.

SIXTY YEARS AGO.

THE Stirling hot-air engine continues to be illustrated in thermo-dynamic text-books although it is doubtful whether outside museums and possibly one or two college laboratories a practical example of it continues to exist. The engine had the merit of illustrating the application of sound thermo-dynamic principles but it failed in practice because it was found impossible to run it for any length of time without burning or melting the air-heating vessel. James Stirling was born at Methven, Perthshire, in 1800. He was intended for the Church but his mechanical bent could not be overcome. He was apprenticed to Girdwood and Co., mechanical engineers, of Glasgow and subsequently became manager of the Dundee Foundry. The idea of the hot-air engine was apparently originally conceived not by him but by his elder brother, Dr. Stirling the minister of Galston, Ayrshire. It was however to James Stirling's persevering ingenuity that the credit for making the engine work at the Dundee Foundry was due. Later in life he settled in Edinburgh where for nearly a quarter of a century he devoted himself largely to intellectual and literary interests. He died at his home in the Scottish capital on January 10th 1876. It seems just possible that the Stirling hot-air engine may be one of those early inventions which have been allowed to lapse because of the restricted facilities for giving them practical effect at the time of their introduction. Is it not possible that with modern metallurgical improvements the hot-air engine might be usefully and successfully resuscitated? . . . In our issue of January 21st 1876 particulars were given of certain proposals, then before Parliament, for the prevention of floods in the Thames Valley. The works proposed were designed on the supposition—now known to be erroneous—that the flooding caused by the Thames was produced wholly by a tidal wave sweeping up the estuary, after the manner of the Severn or Ganges "bore," and banking up the water in the higher reaches. It was therefore proposed that on both sides of the river in the neighbourhood of Erith, Dartford and Purfleet, the embankments should be reconstructed to convert the existing marshes into four large impounding reservoirs. Into these reservoirs the tidal water would be allowed to pass at times of danger and from them the water would be discharged through sluices at the succeeding low tides. It was estimated that for the modest sum of £150,000 reservoirs with a total capacity of nearly 2000 million cubic feet could be formed or sufficient to accommodate two consecutive extraordinary tides.

British Standards Institution.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

STRUCTURAL STEEL IN BUILDING.

No. 449—1935. During the three years since the first edition of this Specification was issued certain technical developments have taken place, whilst experience in the use of the Specification showed that some of the clauses required elucidation and further definition in order to clear up ambiguities. The principal modifications in the revised issue are as follows:—(1) Provision has been made for the use of high-tensile steel; (2) the definitions for determining the effective pillar length to be employed in calculations have been modified and amplified; (3) the formulæ for determining the thicknesses of slab bases have been revised and will result in thinner bases for a given load; (4) the requirements for alternative loads for floor slabs and beams have been revised and differentiation is made in the floor loads between the loads to be considered as coming on the steel framework and those on the floor slabs; (5) the Appendix on Materials has been completely revised and increased pressures on brickwork, masonry, and concrete are now permitted.

A DIAMOND JUBILEE.—We have received from Johnson and Phillips, Ltd., of Charlton, S.E.7, a brochure which they have issued to commemorate the completion of the firm's sixtieth year of working. The firm was established in 1875 on a small scale on a part of the present works site, and the works have extended from one small building to a number of large modern workshops covering several acres. The brochure gives a pictorial account of the growth and expansion of the firm and its products during these years. The history of the growth of this company and the development of its products are in effect the history of the development of the electrical industry, and the manner in which the photographs of the older equipment are faced by photographs of the modern makes interesting comparisons.

The Manufacture and Testing of Rolling Stock Equipment.*

By A. WITHEFORD, Assoc. M. Inst. C.E.

As one surveys the past records and performances of railway engineering in Great Britain, a striking feature in that portion of the history devoted to rolling stock equipment is the remarkable reliability in service, and the freedom from serious accidents and troublesome breakdowns caused by faulty wheels, tires, axles, springs, and brakes, &c. The millions of passengers conveyed annually without delay or mishap, and the service supplied for both goods and passengers with such regularity and punctuality by the railway groups in their efforts to serve the public, are facts and achievements which speak for themselves in enhancing the reputation of this highly efficient and so well organised transport system. A policy of "Safety First" in some circumstances may be regarded with a certain amount of misgiving, particularly if it should tend to restrain progress, but where the lives of the travelling public are concerned it is undoubtedly necessary and must be borne in mind throughout all branches of the public service. The attainment of such reliability reflects great credit on all concerned; firstly, to the designer who by the accumulation of experience and careful calculation develops the shape of the material to withstand the varying stresses imposed on it; secondly, to the manufacturer who produces a good, sound job built to give satisfactory service; and, thirdly, to the maintenance section of the railway engineering staff, whose constant attention and vigilance prolong the life of the rolling stock, and also detect any faults which might prove disastrous if allowed to develop. A very close co-operation exists between the steel manufacturer and the railway engineer, and such developments as are required are attempted, and, after sometimes prolonged experimenting, are accomplished to the mutual satisfaction of both parties and for the future well-being of the community.

The object of this paper is to enlarge upon the second factor previously mentioned as a component in the realisation of this almost perfect reliability, and to briefly indicate some of the steps taken by the steel manufacturer towards ensuring a longer life and more satisfactory service for his product.

It is the author's intention to quote some details of the methods of manufacture, some of the tests imposed on these various parts of the rolling stock equipment whilst in course of production, and to the development of a testing machine of an unusual character.

The production of the steel—from which all the items here considered are made—is, at our own works, accomplished in the Siemens open-hearth furnaces and the electric arc furnaces. The grading and melting of the scrap and the addition of alloys, are very carefully checked throughout all stages, and during the refining period samples are taken at very frequent intervals to ensure that the correct analysis and conditions are obtained. The actual temperature of the steel at the time of casting (into the ingots) is noted, and during this and all subsequent operations when reheating is necessary, a very close watch is kept on the thermal condition of the material whilst it is being subjected to manipulation to the required form. This work must be carried out between predetermined limits of temperature, which have been found by experience to be the most suitable for the particular quality of steel being manufactured.

Considering rolling stock equipment and commencing at rail level and working upwards, let us first consider the wheels. These may be divided into two classes, viz., the complete wheel either cast or pressed, and the wheel having a cast steel centre with a rolled steel tire shrunk on.

The complete wheels of cast steel, which are manufactured under licence, are produced in the foundry by the centrifugal casting process, the casting machine rotating in a horizontal plane. The moulds are of the usual split type, the lower half containing the flange side of the tread and the upper half containing the remainder of the tread, with three risers adjacent to it and a centre riser having a hollow core for the hub. The moulds are formed on a "bumper" in order to consolidate the sand, and when closing is being effected great care is taken to see that the two halves coincide. A very quick drying is performed by blowing air through a coke fire and directing the hot air into the moulds. Only the skin of the mould is dried, as the hot air is rarely applied for more than an hour, and immediately after drying the three rim risers are blanked off and strapped over, and the closed moulds put in position on the casting table. The speed of rotation of the table is dependent on the diameter of the wheel being made and the height the metal has to be lifted from the centre well. The molten steel is fed into the rotating mould under the pressure of a constant head, the pourer box having an overflow lip and being fed from a ladle at a quicker rate than it discharges itself into the mould. A quantity of manganese in granular form is injected into the stream entering the mould during the early period of pouring, and is thus taken up with the molten steel and deposited near the tread of the wheel. The speeds of rotation, pouring and injection of manganese are closely bound up together in order to obtain a wheel having a hard tread and a relatively soft plate and centre. When the mould is completely filled it is kept rotating for two or three minutes and any shrinkage is fed from the aforementioned risers. After this it is put on the foundry floor, the cramps knocked off, heads eased, and the top half box removed, but the sand left to cover the hot casting, and it is left thus for an hour. The top sand is then removed, and, after three or four hours' cooling in the bottom half box, the wheel is knocked out of the mould and placed in an annealing furnace, being charged into a hot furnace and held at the correct treatment temperature for four hours. The risers are then removed and the hubs bored and treads turned, after which the wheel is heated up again for hardening. To obtain a hard tread and maintain a resilient flange and plate, the hardening is achieved by the application of water through a large number of jets which impinge on the tread of the wheel.

* The Institution of Civil Engineers (Yorkshire Association), Wednesday, November 27th, 1935.

The last phase in production prior to testing is the machining out of the sprag holes, and when this is accomplished the wheels are ready for tup-testing.

As a test for soundness all wheels are tested under a 3-cwt. tup, and for wheels under 33in. diameter the weight is allowed to drop 3ft., and for larger wheels the drop is 5ft. Sample wheels are selected for the breaking test.

Wheel centres for service with rolled tires are cast in the foundry in the usual fixed box, and are subject to similar heat treatment and tests, as described above.

TIRES.

Tires are produced from Siemens acid steel ingots of sufficient size to yield two or more blocks, and the selection of such ingots for the manufacture of any given size of tire is made to enable an adequate amount of work to be performed on the block in a length direction. Immediately after pouring, all ingots have a "lifter" inserted, on which is stamped the cast number of that particular "heat," and this is allowed to "freeze" in the upper end of the ingot. The cast number travels with the steel throughout all its operations, and is eventually stamped on the finished manufactured article. After stripping, the ingots are very closely examined, and having been proved satisfactory are transferred to the stocking ground and stacked in groups, each group representing one complete cast. The next operation consists of parting off the ingot into blocks, and in the slicing machines specially designed for this duty sufficient material is removed from both ends to ensure that the blocks are free from any imperfections due to casting. After a careful inspection, the blocks are charged into the cold end of a continuous furnace having a capacity of 40 tons, and are pushed down to the hearth by a hydraulic pusher. All the blocks in one cast are charged in one group and separators then follow on before charging another cast. The heating up from cold is done very gradually and the forging temperature is not attained until eight or ten hours after charging. The blocks are allowed to soak thoroughly in the hot zone, and are then withdrawn by an electrically operated manipulator and forged down under the hammer to about 8in. thick. A top punch is then inserted, driven down and cleared by a bottom punch, thus removing the centre portion, and the bottom punch, which is now tight in, is used for rounding up the blank. The punch is then removed and the blank hammered down on the face to the ordered width of the tire, and thus has a nicely planished face on leaving the hammer. The punched blank is then transferred to the roughing mill, where it is rolled out in a vertical plane to within 4in. to 8in. of the finished diameter. This mill is driven by two 400 h.p. motors, and controls the width whilst expanding the hole to the required diameter, thus causing the material to flow circumferentially. The expansion of the blank is sometimes performed on a becking hammer, but after opening out the hole to its required diameter the blank must again be hammered on the face to maintain the desired width. Following roughing comes the finishing mill, which consists of a driven back shaft carrying the section roll to form the flange, trade, and faces, an inside roll (friction driven) to form the inside profile, guide rolls for steadying and top rolls to hold down the tire. The back shaft is driven by a 1000 h.p. motor, and the inner roll is thrust by hydraulic pressure towards the back roll, and these shafts being vertical, the tire rotates in a horizontal plane. The accuracy of rolling in this mill is particularly good, and the tolerances allowed by the home railways of $\pm\frac{1}{16}$in. on outside and inside diameters (for wagon tires) can be satisfactorily maintained. Immediately after rolling, all tires are stamped on their faces with the date, cast number, maker's and owner's name, and quality of steel.

It is unfortunate that owing to lack of agreement on widths, profiles, &c., a tremendous quantity of rolls have to be maintained in stock, and it seems regrettable that more standardisation cannot be brought to bear on this most important branch of rolling stock equipment. When stamped all tires are allowed to cool evenly, free from draughts, to atmospheric temperature, and the fins brought up by rolling are removed, and the tires carefully examined and gauged for size. A very wide range of tires (wagon, carriage, locomotive, and tramway) can be dealt with in the mill, and other shapes, such as double-flanged crane runners, rectangular hoops, or special shapes, are also produced, with diameters ranging from 14in. to 10ft., and the weight from 1 cwt. to 16 cwt.

Following the careful inspection the tires go forward for heat treatment as required, and in this operation the furnace temperatures are all accurately controlled by pyrometers. Many locomotive tires conforming to specification are put into service but leave much to be desired as regards internal condition, and it is only by the application of an accurately controlled heat treatment, such as used at the works with whom the author is associated, that locomotive tires can be put into their best possible condition to withstand the heavy duties imposed on them.

Following treatment is another close inspection, then gauging by the railway company's representative, and

Typical Tests on Tires.

Type.	Deflection (without fracture).		Max. stress.		Per cent. elongation.		Per cent. red. of area.	
	Reqd.	Obt.	Reqd.	Obt.	Reqd.	Obt.	Reqd.	Obt.
	In.	In.						
Wagon	3½	4¾	42–48	45·6	18–15	24·5	—	36
Carriage ..	3½	5	50–55	54	13–11	20	—	33
Loco.	5½	7⅝	56–62	61	10–8	22	—	42
Tramway X..	¾	1⅜	70–80	76·4	7–4	16	—	36
Tramway Y..	Not called for		65–75	72·4	7–4	15	—	30
Loco.	8¼	36½*	56–62	58·4	10–8	21·5	—	50

* Special test carried on greatly in excess of British Standard Specification; this was an oil-hardened and tempered tire.

sample tires selected for testing under the falling weight; 2 per cent. of the order are tested by being placed vertically and in a running position on the solid foundation of the testing machine, and a weight of 1 ton allowed to fall freely from heights of 10ft., 15ft., and by increments of 5ft. to 30ft., until the tire deflects by an amount based

on its stress, diameter, and thickness. Results of typical tests are shown in the table.

AXLES.

Straight axles for various types of rolling stock are all manufactured in a similar manner, and the following remarks apply to axles for engines, tenders, carriages, wagons, and tramways. The production of an axle from the melting of the material to the finished article is carried on under the strictest scrutiny, with the result that long life and efficient service are ensured when the axle is put into service. The ingots are made from steel obtained from the open-hearth Siemens furnace, and are bottom poured and have a refractory-lined head superimposed on the ingot mould. The ingots as cast are of square cross section, with radiused corners and rounded bottom, and the cast number of the particular "heat" supplying the steel is inserted into every ingot in the group cast from that "heat." This cast number is stamped on the axles throughout the various stages of their manufacture, and enables the whole history of the article to be turned up instantly if required. After stripping and examination, and chipping if required, the ingots are charged into a soaking pit furnace, being stood on end for this reheating. When they attain the required rolling temperature and have been held thus for some time to soak thoroughly, the ingots are cogged down into blooms by passing through the rolling mill, and the blooms are sawn off by a hot saw into the required lengths, each length being sufficient to produce one axle. The blooms are allowed to cool down on a grid, and when cold are subjected to a very close examination for any surface defects, and these—if any—are removed by chipping.

For the next operation—forging to the required shape and dimensions—the cogged blooms are charged into a continuous furnace with a hydraulically operated pusher, and are thus brought up to forging temperature from cold very gradually, the total period of heating occupying about six to seven hours. One half of the bloom is then drawn out to the finished shape and the bloom is again charged into the furnace hearth—at the high temperature zone—for the unforged portion to accumulate an additional supply of heat before finally forging. Whilst heating up this second half of the bloom, it is rotated at intervals to enable an even distribution of the heat to take place.

The forging of the axles is done under a 3-ton steam hammer, specially designed for this duty, to make certain that an adequate amount of work is done on the material.

The forged axles are stamped and then allowed to cool down on a gantry, and, when cold, are again closely examined for surface cracks, &c., and any doubtful marks are removed by chipping or grinding. All axles are then heat treated, and the quality of the steel and consequently the duty for which the axle is being supplied determines what heat treatment is necessary. Certain qualities of axles are oil hardened and tempered, and others are just normalised. Any slight bending due to the treatment is removed by a straightening machine, and then another close inspection is made. Sample axles are selected by the purchaser's representative for testing, and the tests for tension, bending, impact, and hardness, as prescribed in the British Standard Specifications, are all conducted in the presence of the purchaser's inspector. The carbon steel axles have a breaking load in the tensile test of 35 to 40 tons per square inch, with an elongation of 25 to 20 per cent. on a 3in. test piece, while the tensile strength of the alloy steel axles is of the order of 45 to 50 tons per square inch.

In addition to the above tests, the axles are required to pass a drop test under which the axle is subjected to blows by a falling weight dropping from a definite height ranging up to 40ft. Railway axles tested according to B.S.S. No. 24 are placed symmetrically under the falling weight and are freely supported on stools at both sides of the frame, the centre portion of the axle being unsupported. The distance between the supports is governed by the smallest diameter at the middle of the axle, and when set up the axle is subjected to blows in the following order:—The first blow bends the axle and the axle is then turned through 180 deg., and the second blow straightens it, approximately. The third blow takes place and bends the axle in the reverse direction from its initial deformation. The axle is again turned through 180 deg., and is thus back in its original position, but having its centre portion bent upwards. A fourth blow practically straightens it, and then, without any further turning, a fifth blow bends the axle in the same direction as that given after the first blow. After undergoing this severe treatment and the sample test pieces having been put through the necessary tests to meet their requirements, the axles in that particular group from which the samples were taken are regarded as satisfactory, and are passed out for machining and assembly.

One axle in every cast, or one in every fifty, whichever is the maximum, is selected for tup-testing as described above, and the commercial test pieces are prepared from the unstressed portion of the axle when the tup-test has been completed.

The life of an axle in service is largely dependent on circumstances, and misuse and accidents are responsible for the majority of the failures, since rolling stock which has to operate on an indifferently laid permanent way will not function as satisfactorily as that which does duty on some of our excellent home railways. A guaranteed figure usually required by certain Colonial specifications is a life of 200,000 miles, but this figure is generally exceeded, and an interesting failure we had reported a little while ago was an axle which was manufactured before the year 1870, and since we have no records prior to that date we have no idea how many more years it had been in service.

CRANK AXLES.

The production of locomotive crank axles entails a considerable amount of skill, both in the selection of the material and the method of manipulation to the required form. The ingot usually used is of octagonal cross section, and this is charged into a gas-fired furnace, and heated up to forging temperature and allowed to soak thoroughly. On withdrawal from the furnace, the ingot is cogged down to either a rectangular slab or a round slab, and then flattened, the shape of the crank webs determining which form of slab is made. A second reheating takes place and the next operation consists of cutting a piece from the middle and from one end, and then cutting off sufficient from the slab to complete one crank axle. This cut portion is again replaced in the furnace to be restored to the correct maximum forging temperature, and when this has been attained the next operation is proceeded with. The centre portion from which a piece had previously been cut is then rounded up. Following this, another reheating is resorted to, and then the two webs remaining are set up at right angles to each other, the middle journal forged to required dimensions, and then one end is drawn out and rounded up to form the end journal. The final reheating of the other end is then completed, and the last forging operation draws down this end to form the journal in like manner to the previous operation. The crank axle as finally forged has one end left longer than required, for test purposes, and proceeding from the end its form is thus:—Collar, end journal, slab (for crank webs and pin), middle journal, slab, end journal, and collar.

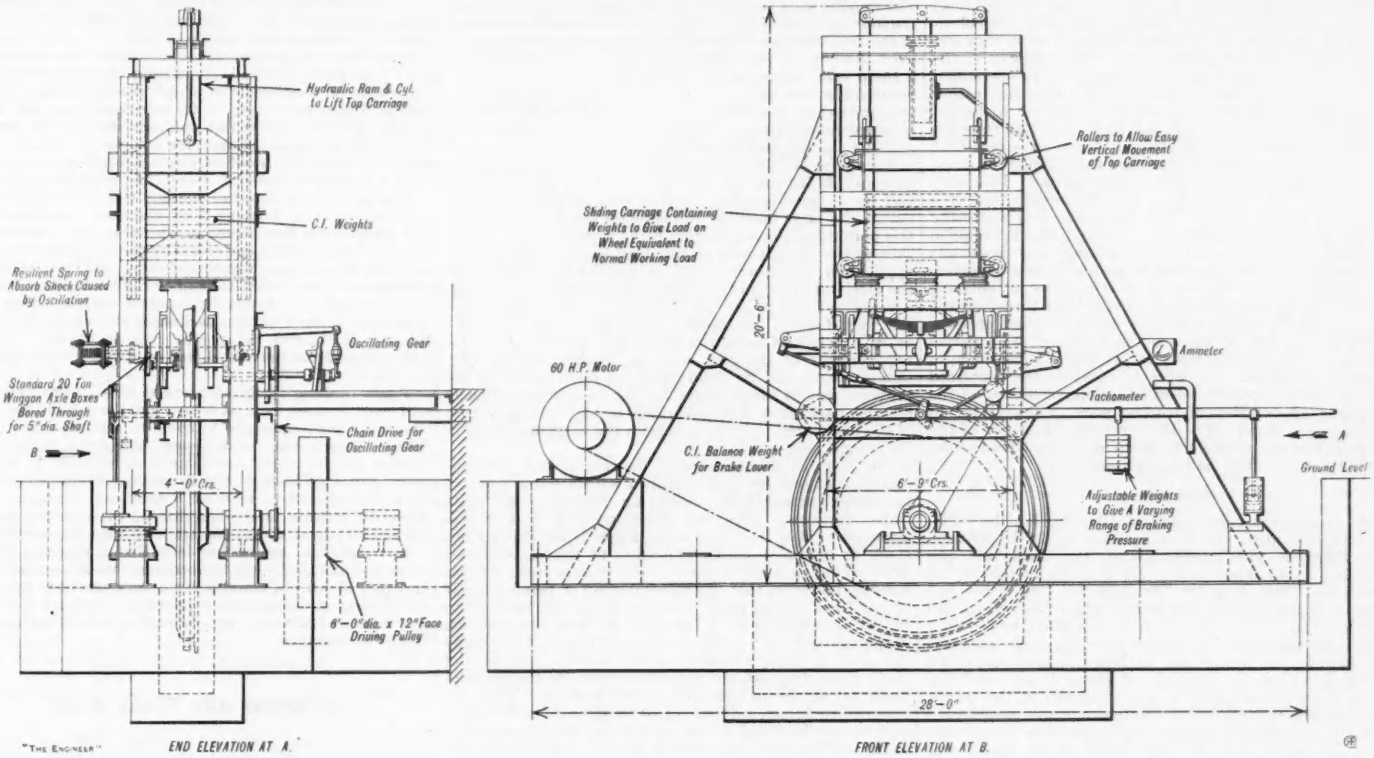
The type of plant used for this class of work consists of a high-speed forging press of 1000 tons capacity, having a steam intensifier and two sliding tables hydraulically operated. The press is served by three producer gas-fired furnaces with air recuperators, and one town gas furnace, and the handling is done by two semi-goliath electric cranes having power-operated turning-over gear. The cranes and press are all controlled from shop floor level by the direction of the leading forgeman. The whole sequence of operations are worked out to a time-table, and the material is only subjected to work being done on it between definite limits of temperature, which are very carefully checked by pyrometers.

On completion of forging the crank axle is annealed to liberate any stresses developed due to the work done on it, and when cold it is very carefully inspected. Rough machining is the next item, and whilst in the machine shops the solid slabs are gashed to form the crank webs, although this material in the middle of the slabs is not immediately removed. These two pieces are only attached to the webs by a very narrow strip, and remain thus until the final heat treatment, namely, oil hardening and tempering, has been completed, and the pieces are then knocked out. The test pieces are prepared from this material cut out of the centre of the web, and having been attached during all forging and treatments, they are truly representative of the condition of the axle.

SPRINGS.

Two distinct types of springs are supplied for the equipment of rolling stock, the laminated spring and the coil spring, the former being built up from a number of plates (or leaves) of equal width and generally equal thickness and of varying length. The upper leaf is usually made with eyes at the ends, and these are developed by either rolling the plate up in a forging machine or by forging a solid end under the hammer and afterwards drilling and reamering the holes. The duty of the spring determines which form is the most suitable, and on certain classes of work requiring solid eyes these are finally ground (both eyes simultaneously) by an internal grinding machine which maintains a definite verticalness in the hole and a constant pitch, thus ensuring that the shackle pins are truly parallel. The lower leaves of the spring are cold sheared from the stock bar, and if the section is not too heavy, the spearing, nibbing, slotting, and centre holing are all completed with the leaf in the cold state. Heavy section bars or special alloy steels require heating up before these operations are performed, and frequently the speared ends are drawn down thinner than the main portion of the leaf. The leaves are then heated up and bent to the required shape, either by hand or machine, and then hardened and tempered. For the heating up of the leaves before cambering in the machine, a gas-fired furnace is employed, having a creeping hearth, the cold bars being charged at one end and accumulating the required amount of heat just prior to being ejected at the discharge end. The heating up of alloy steel requires to be done very gradually, and the range of temperature in the furnace is regulated so that the incoming cold bars enter a zone only slightly warm and pick up heat from the radiant brickwork very slowly until the high temperature zone of the furnace is reached. After bending, hardening, and tempering, the leaves are then assembled and the retaining buckle is heated up and knocked into position, and the centre rivet closed under hydraulic pressure, and any intermediate shackles attached. All springs are then scragged, *i.e.*, tested for resilience by being placed flat down on a steel table with the ends bearing against a plate, and a load applied direct on the centre of the spring from a piston. Sample springs selected by the purchaser's inspector, in addition to those selected by our own management, are tested for deflection under specific loads by means of an Avery hydraulic testing machine, and before despatch all springs are liberally coated with black varnish. A wide range of laminated springs are produced, the lengths varying from 10in. to upwards of 10ft., and a loading capacity between 200 lb. and 20 tons.

For the production of coil springs a large stock of tools, mandrels, and sections of steel require to be maintained, and three different types are manufactured—the helical, volute, and conical. Some buffer springs are of the volute type, and made from a flat section of steel, the ends of which are drawn down and tapered off so that when coiled up the ends are maintained perpendicular to the axis of the spring. The bars are heated up in a furnace having a very long hearth, and when at the required tem-


Hydraulic Ram & Cyl. to Lift Top Carriage
C.I. Weights
Resilient Spring to Absorb Shock Caused by Oscillation
Oscillating Gear
Standard 20 Ton Waggon Axle Boxes Bored Through for 5" dia. Shaft
B
Chain Drive for Oscillating Gear
4'-0" Crs.
6'-0" dia. x 12" Face Driving Pulley
"THE ENGINEER"
END ELEVATION AT A.
Rollers to Allow Easy Vertical Movement of Top Carriage
Sliding Carriage Containing Weights to Give Load on Wheel Equivalent to Normal Working Load
20'-6"
60 H.P. Motor
Ammeter
Tachometer
C.I. Balance Weight for Brake Lever
6'-9" Crs.
A
Ground Level
Adjustable Weights to Give A Varying Range of Braking Pressure
28'-0"
FRONT ELEVATION AT B.

WHEEL-TESTING MACHINE

perature, one end is drawn out of the furnace, secured to the mandrel, and the coiling machine started up. The bar is held to the mandrel by tongs for the first half revolution and then released, and while the remaining coiling is being done the feeding mechanism is traversed along the machine bed, and as the diameter of the spring increases the travel is accelerated automatically. To produce a square section helical spring the section of steel initially is trapezoidal, so that when coiled up a square section is produced, owing to the compression heaping up the internal radius of the spring and the tension narrowing down the width of the outer skin. Helical springs are also formed on a mandrel, and the traversing mechanism consists of rollers and fingers, but with this type of spring the traversing speed is constant to give a regular pitch. When the last coil is reached, the traverse is automatically cut out and the final coil is thus wound at right angles to the axis of the spring. To produce conical springs the heated bars are coiled up in one plane, each successive coiling lying on top of its preceding one, and the disc thus formed is punched into the required shape by a steam-operated die and block. All coil springs are oil hardened, and then tempered in a lead bath, and the ends ground square to the axis. Every spring is scragged in a vertical machine, and the selected samples tested under the Avery machine previously mentioned.

THE WHEEL-TESTING MACHINE.

For the purpose of conducting prolonged and exhaustive tests under such conditions as usually prevail in service, a machine—illustrated herewith—was designed by the author and erected at the works of Messrs. Thos. Firth and John Brown, Sheffield. By the installation of such a machine it was intended that much data and information could be obtained respecting the wearing of the wheel under various conditions of loading, and after the collection of all the evidence, to effect therefrom what improvements were possible and desirable. The intensity of the loading was to be at least of such severity as one would encounter in every-day practice, with a tendency rather on the side of excessive loading in preference to underloading. In fact, when engaged on certain test runs the sequence of operations on the wheel was so severe that it was greatly in excess of the worst conditions that could possibly occur, even in a very intense service. Provision was made in the design for :—(1) The application of a wheel load ranging from 2 to 7 tons, either as a steadily applied load or as an intermittent and rapidly applied one, such as would occur when running over crossings ; (2) a slewing motion arranged to give a similar condition as experienced in rounding a sharp curve or entering points ; (3) an oscillating gear putting end thrust on the axle to give the effect created by a sudden wind pressure acting on the side of the train in motion ; (4) a varied loading on the braking lever to produce a wide range of breaking pressures. In order to measure the increased driving power necessary when either one or several of the preceding applications of loading were in operation, an ammeter was fitted. The three principal features of the machine are the massive built-up mild steel frame, the driving gear, and the loading equipment.

THE FRAME.

The frame was constructed of 12in. by 6in. by 54 lb. per foot R.S. joists and 12in. by 3½in. by 26 lb. per foot R.S. channels, with gussett plates, ⅜in. thick, and ⅞in. diameter rivets at all joints. On glancing at the overall dimensions (28ft. long by 21ft. high by 11ft. wide), the massive appearance of the frame, when riveted up and erected in the shop, can readily be imagined, but in view of the arduous nature of the task and the rapidly alternating stresses the frame had to bear, it was considered advisable to err on the side of strength and stability rather than run the risk of any weakness in the frame. Similarly the foundation for the machine was constructed in a very substantial manner, the excavation being taken down approximately 8ft., at which depth gravel was encountered. Boxes were fixed to form the troughs for the driving wheels, the whole bed was concreted in successive shifts, and the resultant foundation was a homogeneous block of concrete. This was left an inch lower than the required finished height, and finally grouted up when the frame base had been levelled up and set in position on steel packings.

THE DRIVING GEAR.

Turning to the driving gear, the wheel under test was friction driven by a track rail mounted on a large cast steel wheel, thus reversing the usual order of operations. The driving power was obtained from a 60 h.p. D.C. variable-speed motor, with a range of 350 to 750 r.p.m., through a belt 12in. wide, ¼in. thick, the motor pulley being 15in. diameter, and the wrought iron split pulley on the main driving shaft, 6ft. diameter. The main driving shaft was of forged steel, 7½in. diameter and 10ft. 3in. long, carried in three plain plummer blocks, each 15in. long, the shaft being necked down to 6in. diameter in the main bearings. The large cast steel wheel carrying the track rail was 8ft. 1in. diameter on the face, with a flange carried up on one side only for an additional height of 6in., this to serve the same purpose as a check rail. Originally, the British Standard 80 lb. per yard flat-bottomed rails were used for the track, but an extraordinary amount of difficulty was experienced in the bending of these rails to the correct form without distortion of the web. On occasions when these rails were in service and even only a very slight irregularity was present in the track, the vibration when travelling at 50 m.p.h. was terrific and caused several bolted connections to work loose, and although the bearing surface of the main shaft bearings was quite adequate under usual conditions, the bumping at the joint and any other points where irregularities were present caused the bearings to heat up. The maximum bearing pressure for which the main shaft bearings had been designed was fixed at the very low value of 100 lb. per square inch of projected area, and since the usual figure for this class of bearing is round about 200 lb. per square inch, it was thought that the margin provided would be adequate to cope with the heavier duties likely to be imposed. However, the heating up did occur, and to obviate this trouble and to obtain a much sweeter running of the machine, it was decided to provide a rail without a joint and whose periphery was truly circular. The method adopted to procure rails whose characteristics satisfied these requirements was to roll a hollow drum of rail quality steel to an internal diameter of about 8ft. and 7in. in thickness. This was parted off into rings, 5½in. wide, and the section machined up to the profile of the standard rail. This rail was secured to the large cast steel wheel by fitted bolts through the rail flanges, and, as an additional safeguard, the web of the rail was connected to the check rail flange by bolts and pipe distance pieces at intervals of about 20in. These bolts were particularly useful when the end thrust loading was being applied, since they withstood the load in tension which would otherwise be a pure shear on the fitted bolts in the rail flanges, and they also prevented any tendency of the rail to heel over when subject to this side thrust.

The railway wheel under test was mounted directly over the driving wheel and, as previously mentioned, was friction driven. The axle was a specially prepared one, much shorter than standard, and having only one wheel shrunk on between the journals, one end being extended to accommodate the end thrust loading equipment. The wheel and axle were suspended from a built-up frame consisting of R.S. channels, by means of standard rolling stock equipment, *i.e.*, springs, axle guards, horn blocks, axle-boxes, &c., the latter having their front covers bored out to allow for the continuity of the axle through the box. The springs were prepared to suit the special conditions present, since one pair of springs were serving only one wheel, whereas in usual practice one pair serve a pair of wheels.

THE LOADING EQUIPMENT.

The main source of deadweight on the wheel was a weight box loaded with detachable cast iron weights, and the variation obtained ranged between 2 tons and 7 tons. The weights were housed in a built-up box carried between the four verticals of the main frame, any lateral movement of the box being prevented by small rollers bracketed out from the box corners. These rollers were in contact with a small rail section bolted to the main frame, and thus ensured that the weight in the carriage was actually being transmitted to the wheel, and none of it being used up in overcoming friction. Contact between the weight box and the channel frame carrying the wheel was by means of four pairs of cast iron bearing plates, having machined faces in rubbing contact with each other. The weight box and frame were coupled together only at the centre by means of a large diameter pin through a cast iron bearing this permitting slewing motion being applied to the wheel. To regulate the amount of the dead load and its rate of application, a hydraulic cylinder was fitted at the top of the machine frame and coupled to the weight box through a crosshead and a pair of lifting links. By this means the weight could be applied either gradually, suddenly, or in a series of intermittent blows, according to the requirements of the test, and the loading at any particular time could be determined by observation of the pressure gauges fitted, these having an additional scale, reading backwards and calibrated to suit the deduction of the load carried by the ram from the total dead load in the weight box.

The channel frame carrying the wheel and axle was extended at one end and equipped with a screw and nut traversing arrangement operating between the main frame verticals. This was hand-operated, and it was intended to slew the wheel at an angle to the driving rail track to obtain a similar condition to that experienced when rounding a sharp curve or entering points. It was noticed, however, that the wheel instead of being angular to the track rail in plan, travelled across the face of the rail in elevation, with a tendency to drag the axle-box supports with it. After several attempts to remedy this without being attended by any success, this form of loading was dropped, and attention turned to the development of an oscillating end thrust motion. This was designed to impart a direct thrust on the axle end in order to traverse the wheel across the face of the driving track, as far as the root of the wheel flange, to produce a similar effect to that occurring when a train is subject to wind pressure across its direction of motion. The wheel was traversed back to its original position by means of a helical spring mounted at the opposite end of the axle to the thrust gear. The end thrust gear was operated by means of rocking levers and links acting through a double-thrust washer directly mounted on the axle end, the rocking motion being obtained from a crank. This, in turn, was driven by chain gearing from the main driving shaft through a sliding dog clutch, so that the frequency of the cross traversing was in a constant relationship to the distance travelled by the wheel. The distance of this cross traverse was made adjustable by the inclusion of screwed rods and turnbuckles.

A pair of standard cast iron brake blocks and shoes were fitted opposite each other, and on the horizontal centre line. The braking load was applied by means of cast iron weights hung from a long lever, whose upper edge carried a large number of indentations to give a varying lever arm for the braking load, so that it was possible by the combination of an adjustable weight and a variable distance to obtain a wide range of braking pressures. To simplify the calculation of actual brake pressure the brake lever was extended beyond its actuating shaft, and a balance weight fitted to counteract the dead weight of the lever itself. An oil dashpot was connected to the brake lever in order to steady any violent oscillation which might arise when the brakes were applied on a wheel travelling at 50 m.p.h. This constituted the sum total of the loading equipment, and in order that accurate records could also be made on speed and distance, revolution counters were attached both to the driving track and the driven wheel, and an instantaneous speed recorder was also fixed to the latter.

RUNNING A TEST.

Provision was made in the design for adjustments to suit a range between 30in. diameter and 40in. diameter. The longest run of any single wheel on test covered a distance of 30,000 miles, and the running was continuous (excepting for stoppages for measurements, oiling, and adjustments) from 6 a.m. Monday until 12 noon the following Saturday. The usual test run for observations of wear by abrasion extended over a distance of 10,000 miles, and the superimposed load on the wheel amounted to about 7 tons, while the braking force was of the order of 1800 lb. to 2000 lb. The sequence of operations and application of loading in hourly periods was as follows :—For the first twenty minutes the wheel was driven with brakes on and a constant speed of 45 miles per hour maintained for as long as possible, but this usually fell to 35 miles per hour by the end of the braking period. The brakes were then released and the speed accelerated to 45–50 miles per hour, and the wheel run freely for thirty minutes, the other ten minutes being occupied by the application of the end thrust loading to cause wear in the root of the flange. It was observed that towards the end of the braking period there appeared across the tread of the wheel a series of bright red rings about ⅛in. to ¼in. wide, and at a temperature of about 750 deg. Cent. Bright red patches were also visible on the brake blocks after about twelve minutes' braking, but on releasing the brakes these disappeared fairly rapidly. After about every 1000 miles of running, the machine was stopped and measurements taken for the wear of the wheel, driving rail and brake blocks, and general notes taken of the condition of the wheel. It was generally found that the wear in the driving rail was about double that in the wheel and the tread of the track rail quickly approached the same taper as in the profile of the wheel tread. When running quite free the wheel always attempted to climb the taper on the driving track and grind the flange into the side of the rail, and this had to be restricted by a strong spring, which also assisted the return stroke when the end thrust gear was in operation.

Some idea of the severity of the above test can be augmented by the fact that in a 10,000-mile test as described, four new pairs of brake blocks were required, and the weight of cast iron removed from these exceeded 53 lb.

By comparing the values of the two revolution counters, one on the driving track and the other on the driven wheel, it was established that in the ordinary test for wear there was about 0·2 per cent. of slip or skid.

In addition to the general test described, certain special tests were also conducted on different classes of wheel.

In tests on skidding, the wheel was run under a dead load of 5 tons at a speed of 25 miles per hour, and then a braking load applied just sufficient to skid the wheel. The skidding was maintained for a period of five minutes, at the end of which the wheel was measured up to ascertain what quantity of material, if any, had been removed.

Another test consisted of running the wheel for twenty minutes with the braking load and forty minutes free, and during the free running period to run for twenty minutes with the load suspended by the hydraulic cylinder, and the wheel just rotating freely, and then for the remainder of the period to bounce the load intermittently by operating the hydraulic control valves. The heat generated by the braking was dissipated very quickly when running light, and before the rapidly applied loading was imposed on the wheel, its temperature dropped to normal.

When running freely at a speed of 45 miles per hour and with a dead load of 5 tons on the wheel, the time required for the machine to come to rest after switching off the current was about 95 sec., and if the brakes were applied to the wheel this time was reduced to 40 sec. When running free and light the ammeter registered about 20 ampères, with a load of 5 tons and running freely about 50 ampères, and when driving the machine against the brakes about 200 to 250 ampères were registered.

In conclusion, the author feels that a machine of this type and modified, say, to accommodate a standard axle and pair of wheels, could serve a very useful purpose for the testing of frame and supporting members, axle-box bearings, and efficiency of lubrication, &c., in addition to the tests described.

LAUNCHES AND TRIAL TRIPS.

POMEROON, twin-screw motor vessel ; built by Ferguson Bros. (Port-Glasgow), Ltd., to the order of Crown Agents for Colonies for Transport and Harbour Department of British Guiana Railways ; dimensions, 125ft. 9in. by 29ft. by 10ft.; to carry general cargo and passengers. Diesel engines of Paxman-Ricardo type, 6½in. bore by 10in. stroke ; constructed by Davey, Paxman and Co. (Colchester), Ltd.; launch, January 8th.

EROS, single-screw steamship ; built by Harland and Wolff, Ltd., to the order of the Standard Fruit and Steamship Company of New Orleans ; dimensions, 427ft. 6in. by 54ft. 6in. by 33ft. 6in.; to carry fruit and a few passengers. Steam engines, triple-expansion, working in conjunction with Metro-Vickers turbine, pressure 260 lb. per square inch ; constructed by the builders ; launch, January 9th.

RAMDAS, twin-screw passenger steamer ; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the Indian Co-operative Navigation and Trading Company, Ltd.; dimensions, 179ft. by 29ft. by 11ft.; to carry passengers. Steam engines, triple-expansion ; constructed by the builders ; launch, January 9th.

STANDELLA, single-screw motor tanker ; built by Harland and Wolff, Ltd., to the order of the Anglo-Saxon Petroleum Company, Ltd.; dimensions, 425ft. by 54ft. 3in. by 31ft.; to carry oil in bulk. Oil engines ; constructed by the builders ; launch, January 9th.

SYDNEY STAR, motor vessel ; built by Harland and Wolff, Ltd., to the order of the Blue Star Line, Ltd.; dimensions, 535ft. by 70ft. by 43ft. 3in.; to carry passengers and cargo. Diesel engines, Harland-B. and W. type ; constructed by the builders ; launch, January 11th.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

THE BRUSH ELECTRICAL ENGINEERING COMPANY, Ltd., informs us that among recent orders for "Brush" oil engines it has received a third repeat order from the Blue Star Line for additional 250 b.h.p. engines, making a total of sixteen 250 b.h.p. engines in all, to drive refrigeration compressors between decks.

THE METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., has received an order from the Cargo Fleet Iron Company, Ltd., for the electrical equipment for the new 32in. reversing universal mill being installed by the company at its Middlesbrough works. The contract comprises the supply and installation of a 15,500 h.p. single-armature reversing mill motor, complete with 4600-kW fly-wheel motor generator set, switch and control gear, and ventilating equipment.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

International Steel Problems.

Considerable interest has been aroused by the statement that the British steel makers have offered to purchase 100,000 tons of Continental semi-finished steel for the next three months with an option to buy another 66,000 tons for delivery in May and June. These quantities are in addition to those provided for in the quota agreement, and it is understood that no reduction has been made in the agreed imports of other descriptions of Continental steel. The discussions as to the method of supervising the distribution of the Continental steel quota after it has arrived in this country have not made much progress, and it is reported that a veiled hint has been made that if agreement is not reached by January 24th the duties upon imported iron and steel will again be raised. Owing to the great need for Continental steel by British consumers, however, this threat has not apparently disturbed the Continental steel makers to the extent which was expected. The Cartel is understood to have put forward an alternative proposal to the British suggestion that the Continental steel should be bought by the British Iron and Steel Corporation and resold to the Continental organisations in this country, and its distribution supervised by a joint committee. The alternative plan, which is now being considered by the British, is understood to provide for the retention of the Continental organisations, whilst at the same time finding a place for the merchants who it was thought at one time would be ignored in these arrangements. An interesting feature of the recent meeting of the Cartel in Brussels was the presence of representatives of the South African steel works, who are reported to have discussed the question of a Continental steel quota for the South African market, and the removal of the anti-dumping duties on steel from France, Germany, and Belgium. Another subject which came up for a good deal of discussion was the increase in the exports of Belgian steel to other Cartel countries. It is part of the Cartel arrangements that its members shall not export to each other's territory more than an agreed tonnage, and it was urged that the Belgians have broken this rule. They retorted, however, that this has been done by the merchants who, since the devaluation of the franc, bought for export on the understanding that they would send the material to low-priced markets, and, instead, had exported it to the Cartel countries where higher prices were obtained. As a result of the discussions, an application was made to the Belgian Government asking that a system of export licenses should be adopted.

Iron and Steel Production.

The British Iron and Steel Federation in its statement on production in December reports that the output of pig iron in that month was 559,300 tons, compared with 529,500 tons in November, and 513,500 tons in December, 1934. The production included 136,600 tons of hematite; 296,700 tons of basic; 103,200 tons of foundry, and 8100 tons of forge iron. The total production for 1935 was 6,426,400 tons, an increase of 7·7 per cent. over that for the previous year. Steel ingots and castings were produced in December to a total of 811,500 tons, against 903,300 tons in November and 654,500 tons in December, 1934. The total output in 1935 amounted to 9,842,400 tons, which is an increase of 11·2 per cent. over the 1934 production. At the end of December there were 102 furnaces in blast, the same as at the beginning of the month, four furnaces having ceased production and four put into operation. The report does not give the particulars, but of the four furnaces which went out of commission, three were at Colvilles, Ltd., two of which were temporarily damped down, and one at Shotts Iron Company, Ltd. The furnaces blown in were two at the British (Guest, Keen, Baldwins) Iron and Steel Company, Ltd., one at the Kettering Iron and Coal Company, Ltd., and one at the Goldendale Iron Company, Ltd., Staffs. The following table gives the average monthly production of pig iron and steel over a period of years, and the output for the past four months:—

	Pig iron. Tons.	Steel. Tons.
1913—Monthly average	855,000	638,600
1920 " "	669,500	755,600
1929 " "	632,400	803,000
1932 " "	297,800	438,500
1933 " "	344,700	585,300
1934 " "	497,400	737,500
1935—September	529,600	855,900
October	544,300	907,300
November	529,500	903,300
December	559,300	811,500

The Pig Iron Market.

As in other departments of the iron and steel trades, the pig iron market has been disturbed by the uncertainties of the coal position; but later in the week a rather more optimistic tone developed. The producers, however, are pursuing a cautious policy with regard to fresh business. Consumers also do not seem so anxious to place further orders as they were immediately before the holidays, and most of them are covered for several months to come. Specifications against contracts continue to reach the works in satisfactory volume, and deliveries in all departments of the market are maintained at a heavy rate. The position on the North-East Coast remains unsatisfactory, as the demand for Cleveland iron exceeds the supply, and to make matters worse, Dorman, Long and Co., Ltd., have had to change over their two furnaces which have been producing Cleveland iron to increase the output of basic. This is supposed to be only a temporary measure, but for the time being none of this firm's furnaces are producing foundry qualities. During the past week new business has been practically at a standstill, as the makers have had no iron to offer. A few small parcels have been disposed of from stock, but the makers' holdings have been so reduced during the past few months that there is practically nothing available for the market. It is interesting to note that the ascertained average price for No. 3 Cleveland pig iron for the three months ended December 31st, 1935, was 59s. 5d. per ton. This compares with 59s. 8d. per ton for the quarter ending September 30th. Active conditions continue to rule in the Midlands, and a heavy tonnage of pig iron is passing into consumption. The volume of new business in Midland irons, however, shows some decline from recent levels, but this is easily accounted for by the heavy contracts recently placed. Fair stocks of foundry iron are reported to exist at the Derbyshire furnaces, and there is no scarcity of Northamptonshire iron. At the same time, producers have order books sufficient to keep them busy for the next six months. In Lancashire the deliveries are on a good scale, but the prospects of trouble in the coalfields have acted as a check upon new business. In Scotland, also, there is a tendency for both buyers and sellers to mark time. When once the coal difficulties are out of the way, however, it is probable that the number of furnaces in blast in Scotland will be increased. The demand for hematite is maintained at a high level, and stocks have been considerably reduced of late. It was expected that the price for this quality would be advanced early in the New Year, but this movement has been postponed, the official attitude being that the time is not ripe for an increase.

Scotland and the North.

Most of the Scottish steel works were closed for the first week in January, and in some cases departments did not reopen until a day or two later, as extensive repairs to plant were carried out. Active conditions, however, developed directly business was resumed. The coal dispute is exercising considerable influence on the market, and most consumers are anxiously pressing to accelerate their deliveries against contracts, and also, in many cases, to place fresh orders; but, naturally enough, the manufacturers are not disposed to commit themselves far forward in the present rather uncertain trading conditions. Fresh shipbuilding orders have been placed on the Clyde, and the requirements of the shipbuilding industry absorb a heavy tonnage of steel. The locomotive builders are busy and seventy-three locomotives are being built by the North British Locomotive Company. Important orders for rolling stock are also in hand, and these activities will mean important orders for the iron and steel works. The constructional engineering companies have been working at high pressure for months, and the production of structural steel this year in Scotland will probably work out at nearly a record. The marine and general engineering shops are entering the New Year with plenty of work in hand, and there are prospects that some good contracts will be placed in the near future. The plate mills are not so busy as they might be, but, on the other hand, the demand for sheets has lately shown some expansion, notwithstanding the recent advance in prices. The arrangement with the plate makers by which the gap between the price of plates under ¼in. and sheets of 3 mm. has been filled and these thicknesses brought under control is working satisfactorily. In the malleable iron department business has improved during the past few months, and the prices of No. 3 and No. 4 bars have been advanced 10s. per ton, making the quotation £9 and £9 10s. f.o.t. respectively. In Lancashire most of the works are operating at considerable pressure, and although since the holidays new business has not been particularly brisk, there are indications that this is owing to consumers having covered their requirements and that buying on a good scale will shortly develop. The structural engineers are busy and are taking heavy deliveries, and some improvement is anticipated in the demand for boiler plates. Business in bright steel bars has been active, and the quotation remains unaltered at £13 10s. In the Barrow district a new steel furnace has been put into commission. The works on the North-West Coast are fully employed, the demand for billets being particularly strong. The works are also turning out good tonnages of hoops, spring steel and bars.

Current Business.

The English Electric Company, Ltd., has obtained an order from the Bermuda Electric Light and Power Company for a 3500 b.h.p., eight-cylinder Diesel engine, direct coupled to an English Electric alternator. The engine will be the largest Diesel unit ever manufactured in Great Britain. The order was taken against Continental and American competition. The Canadian Pacific Railway Company is to place orders for three 30,000-ton liners. It is expected that these orders will go either to the Clyde or the Mersey. Contracts for railway material worth £72,000 have been placed by the New Zealand Government with the following manufacturers:—British (Guest, Keen, Baldwins), Ltd., South Wales; Barrow Hematite Steel Company, Ltd.; Earl of Dudley's Round Oak Works, Ltd.; Guest, Keen and Nettlefolds, Ltd.; and Bayliss, Jones and Bayliss, Ltd. It is announced by United Steel Companies, Ltd., that it is intended to sink two pits at Workington to obtain coal from a large undersea coalfield. It is expected that the steel works at Penistone will be reopened by the end of January. The works were purchased by David Brown and Sons, Huddersfield, Ltd., gear manufacturers, about a year ago, and had been closed for about six years. The Department of Overseas Trade announces that the following contracts are open for tender:—Tehran, Kampsax Consortium: Supply and erection of five steel railway bridges (Tehran, February 12th). Tasmania, Government Railways: Supply of machine tools and electrical equipment (Hobart, February 27th). New Zealand Public Works Department: Machine tools and electrical and pneumatic equipment for Wigram Aerodrome workshops (Wellington, March 3rd). Dunedin Corporation: Two three-phase, 50-cycle, 21,150/6600-volt transformers, as well as 6600-volt and 35,000-volt switchgear (Dunedin, March 27th). Siam, Royal State Railways of Siam: 37,500 kilos. of ribbed spring steel (Bangkok, February 14th). South African Railways and Harbours Administration: A 5-ton capacity overhead electric travelling crane for Timber Storage Bay, Bloemfontein; five 4-ton electrically driven portal jib cranes (Johannesburg, February 10th). Cape Town Public Works Department: Oil fuel steam boilers, feed pumps, and automatic equipment (Cape Town, February 7th).

Copper and Tin.

The lull in trading in electrolytic copper has not yet passed, and for this the unsettled business conditions in Europe and in America are held to be responsible. Expectations that there would be a rise in the American price have not been realised, and apparently the producers have abandoned the idea of making an advance of ¼ c., although immediately before the holidays they made no secret that this was their intention. Lately the quotation of 9¼ c. has been held with some difficulty, and it is significant that some of the big producers have taken copper from the Customs smelters in order to prevent the metal being thrown on the market. Continental users have at times shown an interest in the market, but their purchases have been on the small side, and the demand from this quarter has been held in check by the difficulties of arranging finance and overcoming import regulations, and similar obstacles to international trading. Nevertheless, it is reported that a good demand exists for electrolytic copper in Germany, and, of course, Italy at times buys substantial parcels. The most cheerful feature of this market is the gradual reduction in the stocks, and it is probably this factor more than any other which promotes the noticeably confident feeling regarding the future of the metal. On the London standard market prices have fluctuated, but latterly there has been a tendency for quotations to recede. For the time being operators show a tendency to watch the market, but fundamentally the position seems sound. . . . Prices in the tin market have shown more steadiness than of late, and it has been noticeable that when weakness threatened to develop substantial support has been forthcoming. Interest in the market is largely centred upon the time when the additional supplies resulting from the increases in the quota will become available for the market, and it is suggested that efforts are being made to prevent prices being sharply affected. The industrial demand for the metal has been rather disappointing, and buying by American consumers which was expected to make itself felt early in the New Year has so far not materialised. The talk of the devaluation of the dollar, which, if it eventuates, would increase the price to American consumers, has not stimulated buying. Continental consumers have shown only a spasmodic interest in the metal. The annual Bolivian tin ore statistics which are issued by G. A. Witt's successor, J. Blum, contain a note that Bolivian production has been much handicapped by the slow return of labour to the mines after the cessation of the war with Paraguay. Bolivian production must now be somewhere near a quota of 80 per cent., but when the authorised quota of 90 per cent. will be reached seems doubtful. It is further suggested that the International Tin Control finds that visible supplies at 12,000 tons are definitely at danger point and that expansion of supplies to 20,000 tons is desired.

Lead and Spelter.

Steadier conditions have developed in the lead market, and prices have shown a firmer tendency. The stocktaking period is now largely over, and consumers are again taking an interest in the market. At the same time, there has been less selling pressure, and offers by the producing interests do not seem to be on the same scale as of late. It is probable that the arrivals of metal this month will not be sufficient to meet market requirements, and deliveries of lead have been made from warehouse. Supplies from the Empire countries seem to be normal, but these are understood to be earmarked for delivery against running contracts. Expectations that Mexican lead would be sent to this country seem to be without foundation, and apparently all the shipments from that source are being sent to Germany. The consuming trades in this country are well employed, and likely to continue to take heavy deliveries for some months. The requirements of the pipe and sheet makers in particular are not likely to contract for some time, and lately the cable makers have become much busier. . . . The spelter market has been the most neglected department of the non-ferrous metal trades since the New Year opened. Consumers' requirements have been disappointing, and many of the big users seem to have covered their needs for the time being. The galvanising industry is not busy, and does not provide a good outlet for the metal, but, on the other hand, the demand from the die castings industry is expanding. In America the market continues active, and during December production is said to have increased to 40,136 tons, whilst the stocks were reduced to 83,936 tons. It is estimated that the production of spelter, including secondary metal during 1935, totalled 439,786 tons, whilst the deliveries amounted to 465,154 tons. Figures issued by the American Bureau of Metal Statistics also indicate that the consumption of spelter outside the United States is expanding and for the past three months has averaged 75,466 tons per month. According to these figures consumption in Germany would seem to have increased from a monthly average of 14,150 tons in 1934 to an average for the last three months of 1935 of 17,330 tons.

Current Prices for Metals and Fuels.

Makers' official home trade prices per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. (*D/d Teesside Area*) £ s. d.	Export. £ s. d.
N.E. COAST—		
Hematite Mixed Nos.	3 10 6	3 2 0
No. 1	3 11 0	3 3 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 12 6	3 4 0
No. 3 G.M.B.	3 10 0	3 1 6
No. 4 Forge	3 9 0	3 0 6
Basic (*Less 5/- rebate*)	3 10 0	—
MIDLANDS—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 15 0	—
„ „ Forge	3 10 0	—
Basic (*Less 5/- rebate*)	3 15 0	—
Northampton—		
Foundry No. 3	3 12 6	—
Forge	3 7 6	—
Derbyshire—		
No. 3 Foundry	3 15 0	—
Forge	3 10 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 13 6	—
No. 1 Foundry, ditto	3 16 6	—
No. 3 Foundry, ditto	3 14 0	—
Basic, d/d (*Less 5/- rebate*)	3 10 0	—
N.W. COAST—	3 14 0 d/d Glasgow	
Hematite Mixed Nos.	3 18 6 „ Sheffield	
	4 4 6 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
LANCS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. YORKS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
MIDLANDS—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
No. 3 quality	7 17 6	—
No. 4 „	8 10 0	—
SCOTLAND—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. COAST—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
LONDON AND THE SOUTH—		
Angles	8 10 0	7 10 0
Tees	9 10 0	8 10 0
Joists	8 17 6	7 10 0
Channels	8 15 6	7 15 0
Rounds, 3in. and up	9 10 0	8 10 0
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¼in. (basis)	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ⅜in.	9 10 0	8 5 0
„ 7/16in.	9 15 0	8 10 0
„ ½in.	9 10 0	9 0 0
NORTH-EAST COAST—	£ s. d.	£ s. d.
Angles	8 7 6	7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	7 10 0
Channels	8 12 6	7 15 0
Rounds, 3in. and up	9 7 6	8 10 0
„ under 3in.	8 12 0	7 10 0
Plates, ¼in.	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ⅜in.	9 5 0	8 5 0
„ 7/16in.	9 10 0	8 10 0
„ ½in.	9 5 0	9 0 0
Boiler Plates, ¼in.	9 5 0	—
MIDLANDS, AND LEEDS AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	7 10 0
Channels	8 12 6	7 15 0
Rounds, 3in. and up	9 7 6	8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ⅜in.	9 7 6	8 5 0
„ 7/16in.	9 12 6	8 10 0
„ ½in.	9 5 0	9 0 0
Boiler Plates, ¼in.	9 7 6	7 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
GLASGOW AND DISTRICT—		
Angles	8 7 6	7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	7 10 0
Channels	8 12 6	7 15 0
Rounds, 3in. and up	9 7 6	8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ⅜in.	9 5 0	8 5 0
„ 7/16in.	9 10 0	8 10 0
„ ½in.	9 5 0	9 0 0
Boiler Plates	9 5 0	—
SOUTH WALES AREA—	£ s. d.	£ s. d.
Angles	8 7 6	7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	7 10 0
Channels	8 12 6	7 15 0
Rounds, 3in. and up	9 7 6	8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ⅜in.	9 7 6	8 5 0
„ 7/16in.	9 12 6	8 10 0
„ ½in.	9 10 0	9 0 0

IRELAND—	BELFAST. £ s. d.	REST OF IRELAND. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ⅜in.	9 10 0	9 12 6
„ 7/16in.	9 15 0	9 17 6
„ ½in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G. to 13-G., f.o.r.	9 15 0	9 0 0
14-G. to 20-G., d/d	11 5 0	9 10 0
21-G. to 24-G., d/d	11 10 0	9 15 0
25-G. to 27-G., d/d	12 2 6	10 7 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24

Home.	£ s. d.
4-ton lots and up	13 10 0
2-ton to 4-ton lots	13 17 6
Under 2 tons	15 10 0

Export: £12 15s. 0d., c.i.f. India.
„ £11 15s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18s. 9d.
Tin-plate Bars, d/d South Wales Works, £5 10s. 0d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 to 250 tons	5 17 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/- per lb.	
Ferro Chromé, 4 p.c. to 6 p.c. carbon	£21 15 0	7/-
„ „ 6 p.c. to 8 p.c.	£21 0 0	7/-
„ „ 8 p.c. to 10 p.c.	£21 0 0	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£33 10 0	11/-
„ „ „ 1 p.c. carbon	£36 5 0	11/-
„ „ „ 0·50 p.c. carbon	£37 5 0	12/-
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose), 76 p.c.	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/- p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/- p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, January 15th.

COPPER—		
Cash	£34 10 0 to £34 12 6	
Three months	£34 18 9 to £35 0 0	
Electrolytic	£38 10 0 to £39 0 0	
Best Selected Ingots, d/d Birmingham	£39 0 0	
Sheets, Hot Rolled	£66 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10½d.	10½d.
„ Brazed (basis)	10½d.	10½d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£32 0 0 to £33 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9¾d.	9¾d.
„ Brazed	11¼d.	11¼d.
TIN—		
Cash	£212 15 0 to £213 0 0	
Three months	£203 10 0 to £203 12 6	
LEAD	£14 13 9 to £14 16 3	
SPELTER	£14 6 3 to £14 11 3	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Grangemouth)—Navigation Unscreened	18/- to 18/6
Hamilton Ell	19/- to 19/6
Navigation Splints	20/- to 21/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/- to 16/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	17/- to 17/6
Unscreened Navigation	18/- to 18/6
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime	17/6
Secondary Steam	16/6

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	19/6 to 23/-
Furnace Coke	14/6 to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	15/6 to 16/6
„ Second	14/6 to 15/-
„ Best Small	11/-
Unscreened	13/- to 14/6
DURHAM—	
Best Gas	14/8
Foundry Coke	19/- to 20/-

SHEFFIELD—	Inland.	
Best Hand-picked Branch	26/- to 28/-	—
South Yorkshire Best	23/- to 25/-	—
South Yorkshire Seconds	20/- to 21/-	—
Rough Slacks	11/- to 12/-	—
Nutty Slacks	10/- to 11/-	—

CARDIFF— SOUTH WALES.	
Steam Coals:	
Best Admiralty Large	19/6
Best Seconds	19/- to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Bunker Smalls	12/6 to 13/6
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/- to 27/6
Foundry Coke	27/- to 40/-
Furnace Coke	19/- to 22/6
Patent Fuel	21/-
SWANSEA—	
Anthracite Coals:	
Best Large	36/- to 40/-
Machine-made Cobbles	45/- to 48/6
Nuts	40/- to 48/6
Beans	25/- to 30/-
Peas	19/- to 23/-
Rubbly Culm	11/- to 11/6
Steam Coals:	
Large Ordinary	18/- to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

French Engineering Notes.

(From our own Correspondent in Paris.)

Engineers' Prospects.

Two matters affecting the interests of French engineers have been brought to the fore, one being a proposal to secure pensions for all engineers, and the other, the address of the newly elected President of the Société des Ingénieurs Civils de France dealing with engineering activities in the colonies. It is common knowledge that the profession has been very badly hit by the crisis, and that even with a return to industrial prosperity it is doubtful whether work can be found for everyone. There is admittedly an excess of engineers over probable industrial requirements. As employment may be more or less irregular, the Federation of Associations, Societies and Syndicates of French Engineers is preparing a scheme to provide for the future of all engineers who may look forward to the certainty of receiving old age pensions. They cannot come within the workmen's insurance scheme because a recent decree limits its benefits to a scale of wages below the level of salaries paid to the higher grades of employees. The Federation is anxious to find a means of extending the workmen's insurance scheme to engineers in a manner to ensure that, whatever happens, they will never run the risk of being deprived of pensions if they reach the required age. In his address before the Société des Ingénieurs Civils, the new President, Monsieur Alfred Jacobson, who is closely identified with colonial organisation, stressed the importance of the French colonies as a field for the activities of engineers. The value of the French colonial domain does not lie in the settling of a surplus population which this country does not possess. All it can do is to supply a technical and administrative staff which will organise and assist colonial development and enable native populations to make the most of natural resources and create a trade movement that will provide the Mother Country with raw material and a market for French manufactured goods. Monsieur Jacobson illustrated the extent and variety of engineering works carried out in the colonies, and pointed to the wide range of activities open to engineers, whose services will be increasingly needed in the future.

Floods.

The floods in 1910 represented a high-water mark, and were particularly devastating in Paris. Yet it is not certain that the volume of water carried by the Seine at that time was greater than during the past week or two, when it rose to within a few feet of the mark on the bridges indicating the height of the historic inundation. There was no fear of danger to Paris, although pumps were installed as a precautionary measure against infiltrations, and for the first time since the great flood, twenty-five years ago, it is seen how effective are the works that have been undertaken to protect the city. They consisted in raising continuous embankments with parapets, sealing openings into the sewerage system, removing river obstructions within the city, notably La Monnaie barrage, and deepening the river below Paris. The work was carried on for several years at considerable cost, and all schemes for river improvements have, as one of their objects, the removal of the flood danger. That danger always exists, and has been fairly frequent for many years past in a manner that suggests some periodicity. It has not been possible to provide protection against disastrous floods of the Loire, Saône, Garonne, and other rivers, for while the shallow Loire is flanked with dykes where necessary, nothing could save the towns on it from submersion, and all work has been suspended over vast areas. In Nantes, for example, works and factories have been stopped. Engineering works that might avoid risks in the future are precluded by their enormous cost.

The "Atlantique."

Now that the insurance companies have failed in their efforts to contest the claim of the Compagnie Sud-Atlantique for full payment in respect of the total loss of the "Atlantique," which was burnt out in the Channel in the first week of 1933, preparations are being made for the immediate construction of a new ship. It has been promised to the Chantiers de Saint-Nazaire. The liner will be of less displacement than the former "Atlantique," which was unable to navigate the Gironde to Bordeaux, the port of the Compagnie Sud-Atlantique, and had to land passengers at Verdon and proceed to Havre to be berthed. Bordeaux resented strongly this loss of prestige, which will be restored to it by the liner drawing less water, so that it can be safely navigated to the port. The elaborate fittings and decorations of the former "Atlantique" were criticised as being superfluous and out of place, and altogether it was felt that the idea of a luxurious floating hotel was carried to an excess for the South American service. The new liner will be less luxurious than its predecessor, but it will have a greater displacement than any other ship in the South Atlantic service and will be noteworthy for advanced design.

The Le Bourget Airport.

Arrangements are being completed for handing over the Le Bourget airport to the Paris Chamber of Commerce, which will carry out important extensions in time for the heavy traffic which may have to be dealt with next year on the occasion of the Paris International Exhibition. There has long been a pressing need for these extensions, but difficulties have arisen to retard them, such as the refusal of the Paris Chamber of Commerce to accept a claim of the General Council of the Seine to participate in the control of the airport, the site of which belongs to the Seine Department. A vast building will be constructed for the station, services, and convenience of passengers at an estimated cost of 20,000,000f. The airport will be the largest in Europe. All the airports in the country are coming under the control of Chambers of Commerce, which are doing a great work in improving existing airports and laying out new grounds, partly with the aid of funds provided for relief works. An extension of the inland postal air service will mean the creation of landing grounds at all the big towns.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

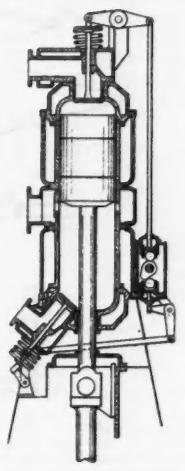
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

438,711. July 12th, 1935.—DOUBLE-ACTING, TWO-STROKE ENGINES, V. Mickelsen, of Harland and Wolff, Ltd., Queen's Island, Belfast, and F. E. Rebbeck.

The essence of this invention is contained in the following claim:—In a double-acting, two-stroke cycle internal combustion engine of the kind described, an ordinary poppet valve in an exhaust port formed centrally in the cylinder end remote from the piston rod, an ordinary poppet valve located obliquely to and coplanar with the axis of the piston-rod and controlling an exhaust port in the piston-rod end of the cylinder, and means for actuating both valves from a common actuating member. The drawing reproduced shows cam-operated valves, but the specification also includes valves driven by linkwork.—*November 21st, 1935.*

Nº438,711

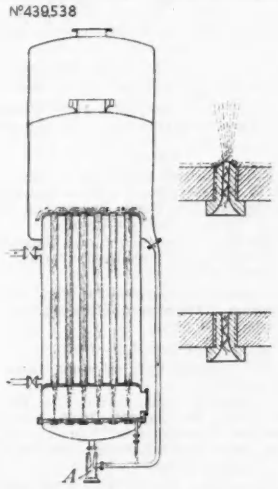


CONDENSERS AND FEED-WATER HEATERS.

439,538. January 21st, 1935.—EVAPORATORS, P. Knichalik, 12, Falkenbergstrasse, Magdeburg, Germany.

This is an apparatus for inspissating, or thickening, solutions, such as those of sugar, by evaporation. In the normal evaporator the head of the solution at the bottom of the tubes

Nº439,538



entails a greater steam pressure than is needed at the top. As a consequence the inventor sprays the liquid into the bottom of the tubes at such a pressure that a thin film adheres to the walls of the tubes and creeps upward. The liquid is recirculated as often as is necessary by the pump A.—*December 9th, 1935.*

SWITCHGEAR.

438,712. July 19th, 1935.—AUTOMATIC REGULATORS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

The construction of this regulator, for controlling the heat of electrical furnaces, can perhaps best be followed from the following description of its operation. Assume that the circuit A has just been energised after a period of de-energisation long enough to allow the heater B to cool. With the parts in the

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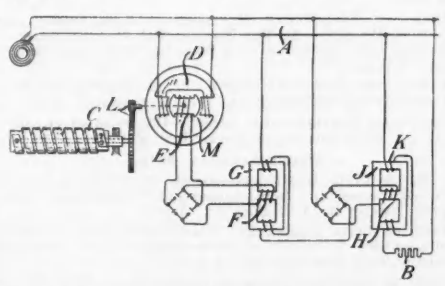

positions shown in the drawing the thermostat C is in its minimum temperature position and the control system is calling for the maximum amount of heat. Thus the windings D and E are aligned, thereby producing a maximum voltage and a maximum energisation of the control winding F of the reactor G, thereby producing a maximum saturation of this reactor, whereby its reactance or choking effect is a minimum, thereby producing a maximum amount of direct current in the control windings H of the reactor J, whereby the reactance of the alternating current winding K of reactor J is a minimum, thereby permitting a maximum amount of current to flow through the heater B. As the temperature of the heater increases, the thermostatic strip C will cause rotation of the gears L, thereby turning the element M and reducing the inductive coupling between the windings D and E. This reduces the current through the control winding F of the reactor G, thereby increasing the choking effect or reactance of the alternating current winding of the reactor G, whereby the choking effect of the reactor J is also increased, thereby decreasing the current in the heater B.—*November 21st, 1935.*

ELECTRICAL APPLIANCES.

439,530. October 19th, 1934.—CONDENSERS, *Dubilier Condenser Company (1925), Ltd., Ducon Works, Victoria-road, North Acton, London, W.3.*

This invention is concerned with the manufacture of electrical condensers from strip material. The metallic electrode A, preferably of aluminium strip, is passed over the roll B in the bath of electrolyte or dielectric C, and between the rolls D and E. One of these rolls is mounted in sliding bearings and the pressure between the two can be adjusted at F. Two bands of absorbent material, such as tissue paper, G and H pass over these rolls and are pressed against either side of the metallic strip. The compound strip is coiled up at J. It is suggested that the electrolyte

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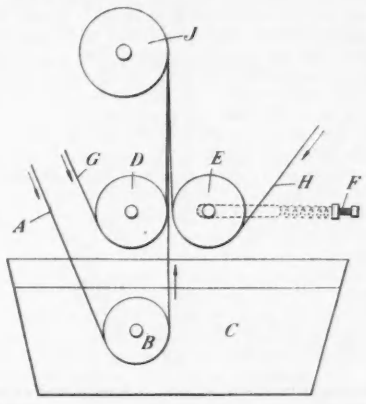

should consist of approximately 2360 grammes of boric acid, 2050 grammes of ethylene glycol, and 160 grammes of gum tragacanth dissolved in approximately 280 cubic centimetres of ammonium hydroxide of 26 per cent. concentration. The boric acid and the ammonium hydroxide are mixed and then the ethylene glycol is added, the resultant mixture being heated to about 140 deg. to 150 deg. Cent. After this has cooled the gum is added in small instalments whilst the mixture is stirred. Finally about 180 cubic centimetres of water is stirred into the mixture. This electrolyte is particularly suitable for the manufacture of 500-volt electrolytic condensers. Another receipt is given in the following specification.—*December 9th, 1935.*

439,533. November 16th, 1934.—ELECTROLYTIC CONDENSERS, *Dubilier Condenser Company (1925) Ltd., Ducon Works, Victoria-road, North Acton, London, W.3.*

In the electrolyte according to this invention the constituents of the electrolyte are mixed cold to produce a sticky paste-like solution of comparatively thick consistency with which the condenser can be impregnated without the application of artificial heat. These constituents comprise an anhydride or oxide of a weak acid (the anhydride being an oxide which, as is well known, combines with water to produce an acid, for instance, boric oxide, B_2O_3), and either ammonium hydroxide or a hydroxide or oxide of an alkali metal, or ammonia, and a polyhydroxyl alcohol, such as glycerine or ethylene glycol or, in place of the alkali metal oxide or hydroxide and the polyhydroxyl alcohol, a nitrogenated polyhydroxyl alcohol, such as triethanolamine or diethanolamine. It has been found that good results can be obtained when the oxide or hydroxide of sodium, potassium, calcium, strontium, or lithium is used. If necessary, a gum, such as gum tragacanth or other suitable filling material, may be added to the solutions. If desired, a condenser unit impregnated with the electrolyte may be heated in any convenient manner to effect a chemical reaction between some or all the constituents of the electrolyte. Preferably this heating is effected by passing an alternating current through the condenser, the heating current being superimposed on a direct current in the case of a polarised condenser unit intended for use in direct current circuits.—*December 9th, 1935.*

TRAMWAYS AND RAILWAYS.

438,621. August 24th, 1934.—RESILIENT POWER TRANSMISSION DEVICES FOR WHEELS, R. P. C. Dodd, Peniche, Buxton-road, Disley, Stockport, and H. P. Bramah, 20, Whitelake-avenue, Flixton, Manchester.

It is claimed that this arrangement for transmitting the

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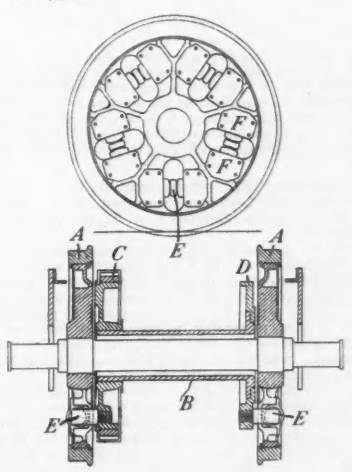


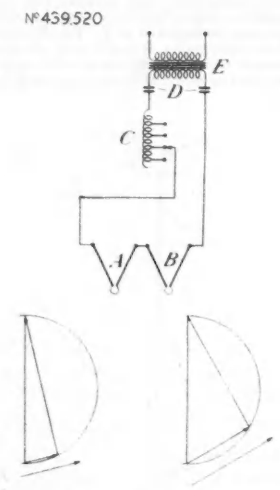
drive from a quill to the driving wheels of a locomotive enables smaller wheels to be employed. A pair of wheels, fixed on their axle, is shown at A A, and the quill at B. The quill is driven

by the engine motor through the gear wheel C. At the opposite end there is a disc D. The gear wheel and the disc are provided with pegs E E, which project between the pads of spring boxes F F. These boxes are housed between the bifurcated ends of the driving wheel spokes and provide a drive in either direction. —*November 20th*, 1935.

WELDING.

439,520. June 27th, 1934.—ELECTRIC ARC ATOMIC HYDROGEN HEATING TORCHES, A. L. Guest, Epperstone, Fairy-road, Wrexham; and Associated Electrical Industries, Crown House, Aldwych, London, W.C.2.

This invention is concerned with arc heating torches, in which a stream of hydrogen is projected across the arc and thus converted into its atomic form. On meeting the object to be heated the hydrogen reverts to the molecular form, producing a very high temperature. The electrodes are generally of tungsten, and it requires some 300 volts to strike the arc, while it can be

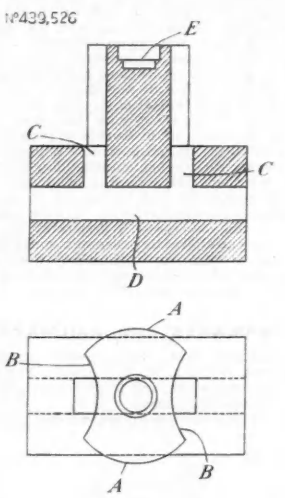


maintained with from 50 to 60 volts. A torch of such a character has two or more pairs of arcing electrodes, as shown at A and B. These are connected in series and in series with a current limiting reactor C, which has several tappings, so that it can be adjusted to suit the working conditions. Switches D connect the apparatus with the secondary of a transformer E. The arcs are struck seriatim, that is to say, one is first struck with the electrodes of the next in contact with one another. When that arc has been established the next is struck and so on. The vector diagrams show the voltages which have to be applied in striking the arcs.—*December 9th*, 1935.

METALLURGY.

439,526. September 18th, 1934.—BOTTOM-CASTING HOLLOW INGOTS, The Union Steel Corporation (of South Africa), Ltd., 82, Marshall-street, Johannesburg, Transvaal.

This invention is concerned with the casting of ingots for the manufacture of hollow drill steel, and it is said that in the past only about 75 per cent. of the ingot has been recovered as usable bar. The use of the runner brick shown is said to have



increased the yield to 87½ per cent. The brick is made of refractory material and has an upwardly projecting boss. The circular sides A A of this boss engage with the interior of the mould and hold it central, while the arcuate recesses B B, communicating with the passages C C and the pouring gate D, permit the entry of the molten metal. The core for forming the hole in the hollow ingot is positioned in the recess E.—*December 9th*, 1935.

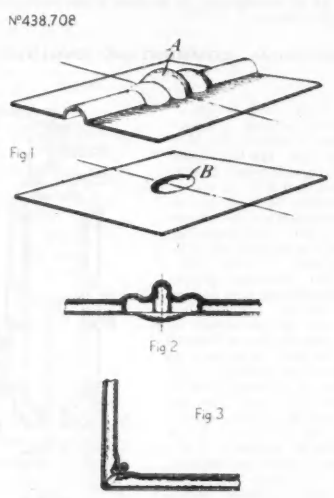
439,543. May 28th, 1935.—PERMANENT MAGNETS AND ALLOYS THEREFOR, Swift Levick and Sons, Ltd., G. D, L. Horsburgh and F. W. Tetley, Clarence Steel Works, Leveson-street, Sheffield, 4.

According to this invention, a permanent magnet comprises an alloy containing from about 7 per cent. to about 20 per cent. of aluminium, from about 10 per cent. to about 25 per cent. of nickel, copper up to about 15 per cent., preferably between 2 per cent. and 8 per cent., cobalt exceeding 15 per cent. up to about 35 per cent., preferably between 15 per cent. and 20 per cent., and the balance iron with or without other elements, such as chromium, manganese, molybdenum, silicon, uranium, vanadium, tungsten, silver, tin, &c., not exceeding a total of 5 per cent., and carbon below 1 per cent., and preferably sensibly zero. After casting the metal is given a treatment which comprises rapidly cooling the casting, in an air blast or by quenching in oil for example, from a temperature between 850 deg. Cent., to 1350 deg. Cent., preferably 1250 deg. Cent., and thereafter subjecting it to so-called precipitation or age-hardening at a temperature between 550 deg. Cent. and 725 deg. Cent., preferably at 600 deg. Cent. Magnets have been made from this alloy and heat treated as described which exhibit values of coercive force between 400 and 500 c.g.s. units or higher, together with remanence of 8000 to 8500 c.g.s. units or higher and $(B.H)_{max}$ of 1,600,000 to 1,800,000. Moreover, these properties have been developed both in small and in large bulky magnets, weighing from a few ounces to 30 lb. or more.—*December 9th*, 1935.

MISCELLANEOUS.

438,708. June 28th, 1935.—A METHOD OF BENDING PIPES OR CONDUITS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

The pipes, or conduits, referred to in this specification are especially those used in refrigerators, evaporators, and so forth. They are made of two flat plates, one having a groove pressed



into it, as shown in Fig. 1, so that a semi-circular passage results. In the course of making up these tubes have to be bent at sharp angles, but must have a free passage at the bend. So the sheets are indented as shown at A and B, and are assembled as shown in Fig. 2. Then, when the tube is bent the indentations are compressed and stretched—see Fig. 3—and a full-bore passage is maintained.—*November 21st*, 1935.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF FUEL.—British Industries House, Marble Arch, W.1. Mr. F. W. Shilstone, together with Mr. Alan Monkhouse, will open debate on "The Public Supply and Distribution of Steam and Hot Water." 6.30 for 7 p.m.

INST. OF METALS: SHEFFIELD LOCAL SECTION.—The University, St. George's-square, Sheffield. "Gases and Metals," Dr. C. J. Smithells. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Informal discussion, "The Future of General Engineers' Shops" Mr. F. T. Woods. 7.30 p.m.

MONDAY, JAN. 20TH.

BRADFORD ENGINEERING SOC.—Meeting cancelled. Paper on "Gear-boxes" postponed.

ENGINEERS' GERMAN CIRCLE.—At Inst. of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1. "Fatigue Strength and its Determination," Dr.-Ing. Hans Oschatz. 5.15 for 6 p.m. After meeting, Eliot's Club, 28, Charing Cross-road, W.C.2. German conversation and supper.

INST. OF MECHANICAL ENGINEERS: YORKSHIRE BRANCH.—Joint meeting with Sheffield Soc. of Engineers and Metallurgists, Mappin Hall of University of Sheffield. Discussion, "Electric Arc Welding." Openers, Prof. F. C. Lea, Prof. J. H. Andrew, and Mr. W. Burnet. 7.30 p.m.

ROYAL AERONAUTICAL SOC.—At Inst. of Electrical Engineers, Savoy-place, W.C.2. "The Theory of Alloy Structures," Prof. W. L. Bragg, F.R.S. 6 p.m. for 6.30 p.m.

TUESDAY, JAN. 21ST.

INST. OF AUTOMOBILE ENGINEERS.—Hotel Metropole, Leeds. "Needle Roller Bearings," Mr. C. H. Smith. 7.15 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. "Road Engineering Problems—Judging the Slippery Road," Dr. R. E. Stradling, Mr. R. G. C. Batson, and Mr. G. Bird. 6 p.m.

INST. OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—In the Building of the Literary and Philosophical Society, 36, George-street, Manchester. "Railcars in Service in Northern Ireland," Mr. A. Allen. 7 p.m.

INST. OF METALS: SWANSEA LOCAL SECTION.—Y.M.C.A., Swansea. "Modification of Alloys," Dr. A. L. Norbury. 6.30 p.m.

INST. OF STRUCTURAL ENGINEERS: LANCASHIRE AND CHESHIRE BRANCH.—At The Temple, Dale-street, Liverpool. "Welding and Erection of Steel Work for Three-storey Buildings." 7 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. "Atomic Arrangement in Alloys," Prof. W. L. Bragg. 5.15 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. "Embrittlement of Steels," Prof. F. C. Lea. 7.30 p.m.

WEDNESDAY, JAN. 22ND.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Informal discussion, "Replenishment of Underground Water Supply," opener Mr. A. B. Buckley. 6 p.m.

INST. OF CIVIL ENGINEERS: MANCHESTER AND DISTRICT ASSOC.—Visit to works of Metropolitan-Vickers Electrical Company, Ltd., Trafford Park. 2 p.m.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Joint meeting with Inst. of Mechanical Engineers. 39, Elmbank-crescent, Glasgow, C.2. Thomas Lowe Gray Lecture, "Future of Steam Propulsion," Mr. J. Johnson. 7.30 p.m.

INST. OF FUEL.—At Chemical Soc., Burlington House, Piccadilly, W.1. "The Cleaning of Coal Using Dense Media," Dr. R. A. Mott. 6 p.m.

INST. OF WELDING.—At Manchester School of Technology, Manchester. "Welding as Applied to Steel-framed Buildings," Mr. G. Ramsay Moon. 7.30 p.m.

NEWCOMEN SOC.—At Science Museum, S. Kensington, S.W.7. Conducted tour of Watt Bicentenary Exhibition, 4.45 to 5.45 p.m. In Lecture Theatre: i, "The Water Bucket Engine at Glyndon, Staffs.," Mr. G. White; ii, "Note Book of Roger North and the Work of Sir S. Morland on the Steam Engine," Mr. Rhys Jenkins; iii, "Earliest News of Watt's Steam Engine to Reach Russia," Prof. P. Zabarinsky. 5.45 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "Forestry in British Empire," Sir Roy L. Robinson. 8 p.m.

THURSDAY, JAN. 23RD.

INST. OF CIVIL ENGINEERS: YORKSHIRE ASSOCN.—Hotel Metropole, Leeds. Annual dinner. 6.30 for 7 p.m.

INST. OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, S.W.1. "Foundations of London Structures," Mr. F. S. Snow. 6.30 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS: TEES-SIDE BRANCH.—At Cleveland Scientific and Technical Inst., Middlesbrough. "Erection of some Steel Bridges," Mr. J. F. Pain. 7.30 p.m.

FRIDAY, JAN. 24TH.

INST. OF ELECTRICAL ENGINEERS: LONDON STUDENTS; STUDENTS OF INST. OF CIVIL ENGINEERS AND GRADUATES OF INST. OF MECHANICAL ENGINEERS.—Victoria Halls, Southampton-row, W.C.1. Dance. 8 p.m. to 1 a.m.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN CENTRE.—Grand Assembly Rooms, Barras Bridge, Newcastle-upon-Tyne. Annual dinner and dance. 7 for 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND CENTRE.—Grand Hotel, Harrogate. Annual dance. 8 p.m. to 2 a.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. "Exhaust Turbines for Marine Propulsion, with Special Reference to Rowan-Götaverken System," Dr. J. B. O. Sneeden. 6 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Gears and their Uses," Dr. H. E. Merritt. 7.30 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—At Mining Inst., Newcastle-upon-Tyne. "The Protection of Ships' Hulls Against Marine Corrosion," Mr. William E. Lewis. 6 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse, "Sensitising Dyes in Photography," Dr. C. E. K. Mees. 9 p.m.

SATURDAY, JAN. 25TH.

INST. OF CIVIL ENGINEERS.—Students' afternoon visit to National Physical Laboratory, Teddington.

N. EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS: GRADUATES' SECTION.—Bolbec Hall, Newcastle-upon-Tyne. "The Design of Cargo Ships," Mr. R. Lowery. 7.15 p.m.

MONDAY, JAN. 27TH.

BRADFORD ENGINEERING SOC.—At Technical College, Bradford. "Arc Welding as Applied to Structural Engineering," Mr. R. J. Fowler. 7.30 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Graduates' Section. "Fluid Joints," Mr. V. A. Yardley. 6.45 p.m.

TUESDAY, JAN. 28TH.

INST. OF AUTOMOBILE ENGINEERS.—James Watt Memorial Inst., Birmingham. "White Metal and Bronze Bearings from the Manufacturer's Point of View," Mr. M. Melhuish; "Needle Roller Bearings," Mr. C. H. Smith. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—North British Station Hotel, Edinburgh. "The Effect of Legislation and Regulations upon Electricity Distribution," Mr. W. Fennell. 7 p.m.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Notes on Applications of Light Alloys to General Engineering," Mr. G. A. Clavey. 7.30 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. "Colour Photography Applied to Micro-photography," Mr. A. Allison. 7.30 p.m.

THURSDAY, JAN. 30TH.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Joint meeting with Graduates of Inst. of Mechanical Engineers. Hotel Metropole, Leeds. "Variable Speed Transmission." 7.15 p.m.

INST. OF LOCOMOTIVE ENGINEERS.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "A Note on the Railways of Union of South Africa" (referring especially to recent locomotive practice), Mr. E. C. Poultney. 5.30 for 6 p.m.

INST. OF MARINE ENGINEERS.—85–88, The Minories, E.C.3. "The History of Technical Education," Principal J. Paley Yorke. 6 p.m.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—James Watt Memorial Inst., Birmingham. "The Polishing of Metals," Mr. E. J. Dobbs. 7 p.m.

INST. OF STRUCTURAL ENGINEERS: YORKSHIRE BRANCH.—Hotel Metropole, Leeds. "Underpinning and Foundation Work in Loose and Waterlogged Ground by Chemical Consolidation, Ground Water Lowering, and other Means," Mr. H. J. B. Harding. 7 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

F. L. SMIDTH AND CO., Ltd., inform us that their offices have been removed from Victoria Station House to Horseferry House, Westminster, London, S.W.1.

MR. FOLLAN C. SMITH has relinquished his appointment as foundry manager to Davy Brothers, Ltd., Sheffield, and Mr. J. Roxburgh has been appointed as his successor.

MR. ALEXANDER LOWE MCCOLL, deputy chairman and joint managing director of the Vacuum Oil Company, Ltd., since 1933, has been appointed chairman of the board of directors on the retirement of Mr. Wilson Cross. Mr. Hubert Holliday, formerly joint managing director, is now managing director.

RUSTON AND HORNSBY, Ltd., Lincoln, inform us that an arrangement has been made under which exhaust heat boilers and water heaters of the Clarkson Thimble Tube type, which are required to work in conjunction with Ruston and Hornsby oil engines, will in future be manufactured and sold by Ruston and Hornsby, Ltd., Lincoln.

ENGLISH STEEL CORPORATION, Ltd., announces that consequent upon the appointment of Sir Charles W. Craven as chairman of the boards of Vickers-Armstrongs, Ltd., and English Steel Corporation, Ltd., and the decision to reopen the works of the Darlington Forge, Ltd., Mr. Alex. Dunbar and Mr. A. B. Winder have been appointed joint general managers of the English Steel Corporation, of Darlington Forge, and of Industrial Steels.

BABCOCK AND WILCOX, Ltd., inform us that Mr. C. S. Davy, who continued his position of chief engineer when he was appointed to the board of directors in 1933, has now relinquished the office of chief engineer. Mr. Davy has completed thirty-eight years' service with the company, and will continue to be a director. Mr. C. H. Sparks has been appointed chief engineer as from January 1st, 1936. Mr. C. K. F. Hague has been appointed general sales manager as from January 1st, 1936, in succession to the late Mr. J. G. Robertson.

A Seven-Day Journal

The Watt Bicentenary.

FUNCTIONS to commemorate the bicentenary of the birth of James Watt were held in several places in this country and abroad at the end of last week. Since December 20th last there has been open at the Science Museum in London a special exhibition of objects of interest, including three original beam engines, models, drawings, and letters, and portraits of Watt, Boulton, and others of his friends. The garret workshop, in which Watt worked from 1790 till his death in 1819, is also on view. On Friday last members of the Institution of Mechanical Engineers and their ladies visited the Museum and later a lecture on James Watt was delivered by Professor Sir Thomas Hudson Beare. On Sunday, the actual date of the bicentenary, there was an afternoon service in Westminster Abbey, attended by representatives of all the great engineering institutions, after which wreaths were placed on the statue of Watt in the Chapel of St. Paul. Later the same evening Col. A. E. Davidson, President of the Institution of Mechanical Engineers, broadcasted to America from the Science Museum. In Greenock, Watt's birthplace, on Saturday, a memorial plaque was unveiled in the Watt Memorial Navigation School and Lord Rutherford delivered the address, which we reprint on another page. Birmingham also honoured one of the greatest of her citizens by the placing of a wreath at the foot of his statue in Ratcliff-place. The Institution of Mechanical Engineers, it was announced by the President, at the meeting at the Science Museum, had decided to set aside the interest on a substantial sum of money for the establishment of a James Watt Medal, to be awarded biennially for the most outstanding achievement in mechanical engineering in this country or abroad.

The Road Fund Report.

THE Road Fund Report, issued by H.M. Stationery Office—price 2s. net—on January 20th, contains some useful information as to the safety provisions of modern road construction. During the financial year 1934–1935 more than 1800 miles of new footpaths were constructed, about 12,400 major road-ahead signs erected, and nearly 500 road junctions equipped with traffic light signals. Details of roads planned and adopted by many authorities are given and particulars of the banking of roads and an analysis of accidents find their place in the Report. By-pass roads constructed now exceed 505 miles. The bridges reconstructed, widened, or strengthened to meet the increased traffic loads include sixty-two bridges over railways and fifty over canals, while in addition fifty-seven new bridges were built on new roads, diversions, or by-passes. It is anticipated that the Kincardine-on-Forth Bridge, one of the major road bridges in course of construction about 10 miles south-east of Stirling, will be opened to traffic by next spring. Work on the Greater London highway development survey was begun in March and numerous local authorities, town planners, and traffic experts have already tendered information which will facilitate the execution of the survey which is being carried out by Sir Charles Bressey, formerly Chief Engineer of the Ministry, in consultation with Sir Edwin Lutyens, R.A. The gross receipts from the taxation of road vehicles in Great Britain, including fees for driving licences, &c., during the calendar year 1934 amounted to £32,588,000, and the net receipts, after allowing for rebates and refunds, to £31,473,000. Licences were issued for approximately 2,395,300 mechanically propelled and 23,000 horse-drawn vehicles. The corresponding figures for 1933 were £29,201,000 gross and £28,357,000 net, derived from 2,282,000 mechanically propelled and 27,670 horse-drawn vehicles. There was thus an increase of 4·96 per cent. in the number of mechanically propelled vehicles licensed, and a decrease of 17·04 per cent. in the number of horse-drawn vehicles on which Excise licence duties are payable.

Further L.N.E.R. Rolling Stock Orders.

IN a Journal note of January 10th, we gave particulars of the London and North-Eastern Railway Company's 1935–36 programme. It is announced that the directors of the L.N.E.R. have decided to put in hand work on a further twenty-two locomotives, together with 225 coaching vehicles, to be constructed under the Government Assisted Loan, referred to in our Journal note of January 3rd. In addition, 593 carriages are to be converted from gas to electric lighting. These orders represent a total value in excess of £800,000, and are additional to the order for ten powerful mixed-traffic locomotives which was placed in December last. The locomotives include seventeen "Pacific" engines which will be generally similar to the "Silver Link" class used for the "Silver Jubilee" train. It is understood that it is the company's intention to streamline these locomotives as the result of the remarkable success which has attended the working of the existing streamlined locomotives. It has been found that the streamlining has saved a great deal of power, in addition to which it has solved the problem of lifting smoke and steam so that it does not obstruct the driver's view. For high-speed running at rates in excess of 60 m.p.h. it has also been found that the reduction of wind resistance effected by streamlining an engine has had beneficial effects upon fuel consumption. It is also interesting to note that in addition to the above four sister engines of the famous "Cock o' the North" are under construction for service on the difficult road between Edinburgh and Aberdeen. These engines will be partially streamlined, as it is felt that this will have a very beneficial effect on their working, as they are so frequently subject to strong easterly and north-easterly winds on this section of the L.N.E.R. The coaching vehicles to be constructed under the present orders include a number of first-class restaurant and sleeping cars, together with 214 first and third-class vestibuled coaches. The majority of these vehicles are to be built by contractors.

Suez Canal Traffic.

IN a bulletin issued by the Suez Canal Company on Wednesday, January 15th, the number of transits of the Canal during 1935 is given as 5992, an increase of 329 over the figures for 1934. The total net tonnage was 32,810,968 tons, an increase of 1,060,166 tons, or 3·3 per cent., over the tonnage of the previous year. For the first half of 1935 the tonnage passing is given as 15,863,943 tons, a decrease of 52,930 tons on the figures for the same period in 1934. During the second half of the year, the figures rose to 16,947,025 tons, as against 15,833,929 tons recorded in 1934, a gain of 1,113,096 tons. The greatest increase over the corresponding figures for 1934 occurred in November, while the most pronounced decrease occurred in May. The distribution of the traffic between vessels laden and vessels in ballast was :—Vessels laden, 28,106,376 tons ; vessels in ballast, 4,704,592 tons. During 1934 the figures were :—Vessels laden, 27,333,282 tons ; and vessels in ballast, 4,417,520 tons ; so that the figures for vessels laden show a gain of 773,094 tons, while the figures for vessels in ballast show a gain of 287,072. The proportion of vessels in ballast amounted to 14·3 per cent. of the total tonnage, as against 13·9 per cent. in 1934. The net average tonnage of the vessels passing through the Canal was 5476, a decrease of 131 tons on the 1934 average.

The Cable Makers' Association.

WE are asked to announce that, amidst many expressions of regret by his colleagues, Mr. Llewellyn B. Atkinson, Hon. M.I.E.E., A.M. Inst. C.E., has retired from the directorship of the Cable Makers' Association, and that Sir Thomas Purves has been chosen to succeed him in that position as from February 1st next. We are able to state, however, that although Mr. Atkinson has retired from the active directorship of the Association, he will not, at any rate for the time being and the immediate future, sever entirely his connection with the Association, It may be recalled that Mr. Atkinson became associated with the Cable Makers' Association in quite early days, when he represented on the Council W. T. Glover and Co., Ltd., of which firm he was a director from 1904 onwards. In 1913 he was made Chairman of the Association and in 1917 became its Secretary for the period of the war. After the war he resigned his interests in cable manufacture on his appointment as director of the Association. He has thus been its chief official for nineteen years. Colonel Sir Thomas F. Purves, who succeeds Mr. Atkinson, is well known in the electrical industry and was from 1922 to 1932 Engineer-in-Chief of the Post Office. He is a prominent leader in work of international co-ordinating bodies and in addition to his duties as managing director of United Telephone Cables, Ltd., has accepted the chairmanship of the Telephone Development Association for the current year.

New Industrial Undertakings.

ON Saturday, January 18th, it was announced that the interests concerned with the proposed new steel works at Jarrow have arranged with Thomas W. Ward, Ltd., of Sheffield, to take over the entire site of Palmer's shipyard, and that the dismantling will be speeded up in order to prepare the site for the construction of new basic steel works with a probable maximum output of about 500,000 tons per year. The Tyne Improvement Commissioners are to construct a new quay with road and railway services. The new steel works will take about two years to construct and the engineers associated with the scheme are Mr. T. V. Salt and Mr. R. C. V. Whitfield. On Saturday, David Brown and Co. (Huddersfield), Ltd., announced that the former works of Cammell Laird and Co., Ltd., at Penistone, which were purchased by the firm some time ago, will shortly be opened. They have been re-equipped and will ultimately find employment for local labour. At Wolverhampton the Fischer Bearing Company, which is associated with the parent German company of the same name, has acquired approximately one-third of the former Sunbeam Car Works from Mr. F. H. Farrer, of the Villiers Engineering Company, Ltd., Wolverhampton, and work is to be begun almost immediately on equipping the factory for the manufacture of steel balls and precision bearings. It is expected that within a year work will be found for close upon 500 workpeople. The Villiers Engineering Company, Ltd., has recently removed its stamp shop and foundry into the former Sunbeam Car Works, which has enabled it to deal with larger orders for steel stampings and non-ferrous castings.

L.M.S. Electrification.

THE L.M.S. and Mersey railway companies announce that arrangements have been made to put in hand the necessary work for establishing a service of through electric trains between the Wirral Peninsula and Liverpool Central Station. The L.M.S. lines from West Kirby and New Brighton to Birkenhead Park, where they join the Mersey railway, are to be electrified on the third rail system at 650 volts. Alterations will be necessary on the Mersey railway to permit the running of through trains between the Wirral section of the L.M.S. and Liverpool Central, and the scheme provides for many improvements in the Mersey Company's existing stock. There will be a ten-minute service for both the West Kirby and New Brighton sections in the morning and evening business periods, and for a short time at midday. During other times a fifteen-minute service will be run for each section, and this will be increased as necessary at holidays. At present through passengers for Liverpool from the West Kirby and New Brighton sections have to change trains at Birkenhead Park, but under the new arrangements this inconvenience will be avoided and the electric services will enable the journey from West Kirby and New Brighton to Liverpool to be made more quickly. The time occupied in travelling from West Kirby to Liverpool Central will be twenty-nine minutes, and from New Brighton twenty minutes. Several stations on the Wirral section of the L.M.S. are to be modernised, and four high-speed electric lifts are to replace hydraulic lifts at the James-street Station, Liverpool, on the Mersey railway.

The Naval Conference.

FOLLOWING the meeting on Wednesday afternoon, January 15th, at which the Japanese proposals were discussed without receiving the support of the Conference, the head of the Japanese delegation, Admiral Nagano, in a letter to Lord Monsell, the Chairman of the first Committee, announced that the Japanese delegation could no longer take part in the Conference. He declared emphatically that Japan had no desire to embark on an armaments race. The Conference then proceeded without the participation of Japan. On Friday, January 17th, the Committee continued its examination of the French, United Kingdom, and Italian plans for a system of advance notification of annual programmes and exchange of information. They discussed the guiding rules that might be followed in the adoption of such a system, on the lines of the proposals contained in the above-mentioned plans. It was decided to appoint a technical sub-committee to work out in detail a scheme for advance notification of annual programmes and exchange of information on the basis of the guiding rules considered by the Committee. The meeting arranged for Tuesday, January 21st, was postponed on receipt of the news of the death of King George. Admiral Nagano has informed Lord Monsell that the Japanese Government has appointed Mr. K. Fujii, Chargé d'Affaires, and Captain R. Fujita, Naval Attaché to the Japanese Embassy, as observers at the London Naval Conference.

London's Telephone System.

THE annual report of the Post Office, issued on Saturday, January 18th, gives some interesting particulars with regard to the development of London's telephone system. During the year under review the number of telephones in the London area increased by 66,000 to 938,000, an average weekly increase of 1270, and the telephone traffic also increased considerably, the total number of calls originated in the London area being 929,000,000, an increase of 72,000,000 over last year's total. There are now 250 telephone exchanges in the London area, comprising 85 automatic exchanges, 153 manual exchanges, 5 trunk exchanges, 2 toll exchanges and 5 junction switching exchanges. In addition to the increased lines which were added to existing trunk routes, new direct routes were opened to Chester, Shrewsbury, Falmouth, Taunton, Grimsby, Truro, and Leamington Spa. Direct routes will be opened shortly to Dundee, Perth, and Carlisle. The total number of effective inland trunk calls from subscribers in the London telephone area was 5,761,000, compared with 4,248,000 in 1934, and during the year over 760,000 Continental calls were handled by the international exchange. The quality of service has been kept under continuous review by means of the service testing system, under which the operation of calls of all classes was tested and recorded, approximately 320,000 tests being taken during the year. A new type of telephone, the "Astic" telephone, has been developed for use in noisy situations, and is particularly suited for buildings containing heavy machinery or in situations subject to traffic noises. The "talking clock," controlled by Greenwich, will be installed in telephone exchanges early this year.

American Beach and Shore Protection Works.

By E. E. R. TRATMAN.

No. II.

(*Continued from page 66, January 17th.*)

AT the time the Galveston seawall—previously described—was built, there was a beach 100ft. to 300ft. wide between the normal high-tide line and the rock work along the foot of the wall. With scour by the waves and the littoral current flowing eastward, the beach has been so eroded that at present the ordinary high tides reach this rock work along the western part of the work. A jetty at the east end of the beach deflects the current so that here the beach is building up westward from the jetty. It has been necessary to place additional rock along the city front, and the Beach Erosion Board appointed by the United States Government has recommended the building of groynes 500ft. long and 1500ft. apart to prevent further erosion of the beach. These groins would be of steel sheet piling, with waling pieces, and braced by creosoted timber piles about 10ft. apart, but staggered on opposite sides of the groin. The Board also recommended filling in sand to rebuild the original beach.

The recent erosion is an element of danger, since if it should expose the timber foundation piles under the sea wall they are liable to be attacked by the *teredo navalis* or other borers. This did occur, in fact, after a moderate storm in 1909, when it became necessary to pump in sand along the toe of the wall and to place new rock work for a considerable distance.

Sea Wall at Fort Monroe.

Of more recent date than the Galveston wall is a massive gravity sea wall of concrete built in 1934 at Fort Monroe, on the Atlantic Coast, for the protection of Government property and the new fortifications. This fort is at the south extremity of a narrow sand spit or peninsula which separates Chesapeake Bay from a small inland stream, its width at some points being only 500ft. to 700ft. As this strip of sand is directly opposite the mouth of the bay, it is exposed to the attack of storm waves rolling in from the Atlantic. Indeed, at times the waves have swept entirely across the spit, with great damage to open storage spaces, a paved road, and a branch railway which serves the fort.

Adequate protection is now essential, since the modern batteries are arranged along the sand spit, north of the fort. Fig. 8 is a view along a part of the completed wall, with the remnants of an old pile bulkhead at the right. The design of the wall with its foundation and backfilling is shown in Fig. 9. This new work has been built under the direction of the Corps of Engineers, United States Army.

To secure effective protection, a high sea wall has been built along the sea front of the spit for about two miles, its south end connecting with the concrete bulkhead which extends around the south face of the old fort. The foundation consists of rows of timber piles, 25ft. long, and a front row of interlocking steel sheet piling of the same length, under the toe of the wall. The tops of the piles are about 18in. below sea level (low tide).

The wall itself is 15ft. 7in. high, with its top 13ft. above low tide or 10ft. above high tide. Its base width is 15ft. and its back is vertical. The face also is vertical at the bottom for 3ft., or up to the low-tide level. Above this it is concave, with a radius of 12ft. 9¾in. Near the top this curve is reduced to a radius of 7ft. 5½in., and the top edge slightly overhangs the face so as to throw back the spray, but there is not so much top projection as in the Hampton Beach wall, described later. At the top the width is 3ft. 6in. Reinforcing steel is placed in the face and back of the wall, some of the face rods being hooked to holes in the steel sheet piling under the toe.

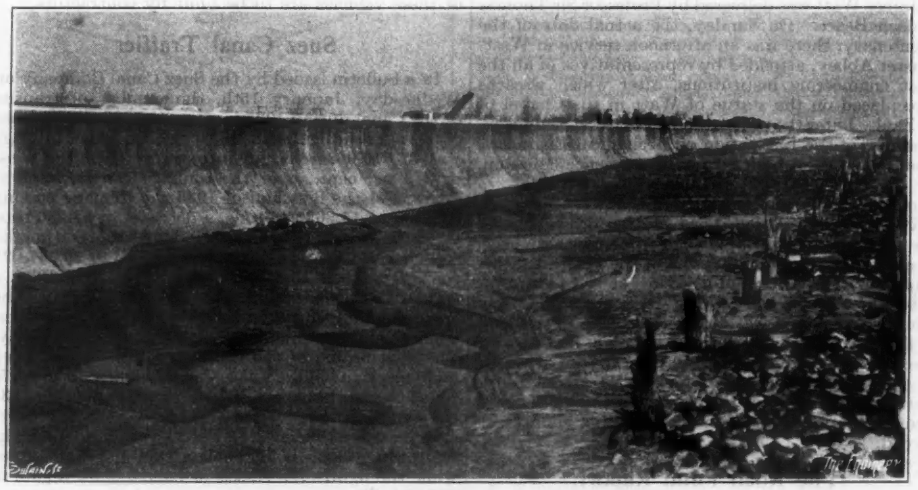


FIG. 8—SEA WALL AT FORT MONROE

In front of the toe of the wall is a protective row of loose rock in a trench about 4ft. deep, its top being practically at low water level. This rock work extends about 7ft. from the concrete wall. After completion of the work, sand was pumped in front

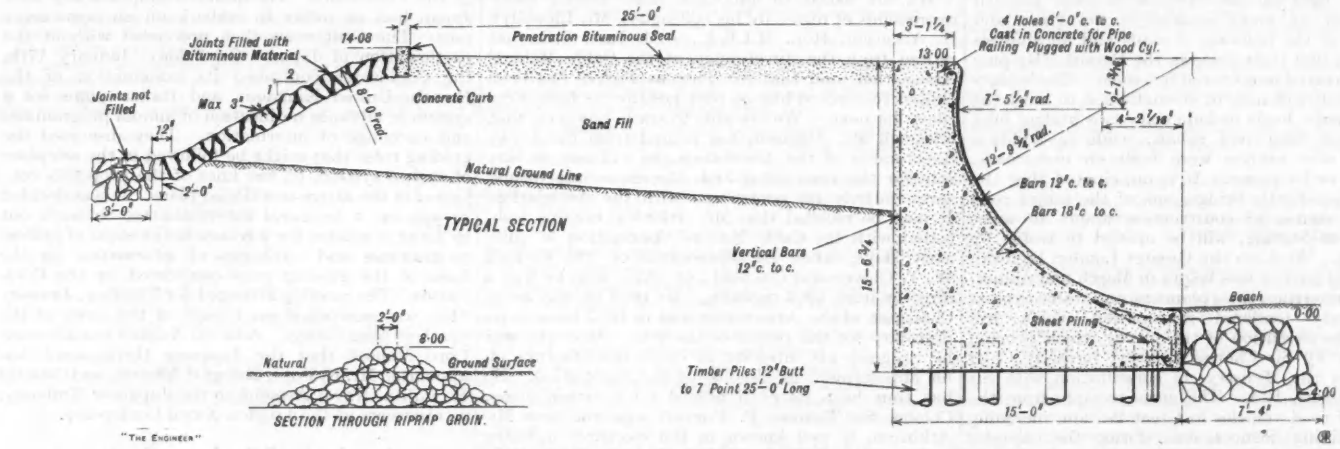


FIG. 9—DESIGN OF FORT MONROE SEA WALL AND BACKFILLING

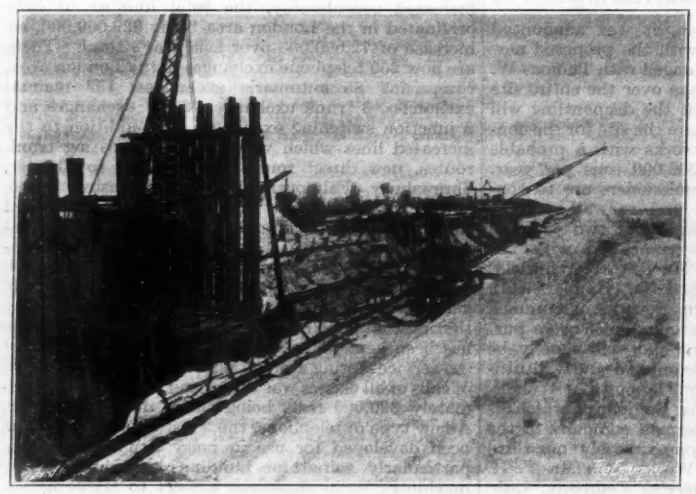


FIG. 10—PILE DRIVERS AND STEEL FORMS AT FORT MONROE

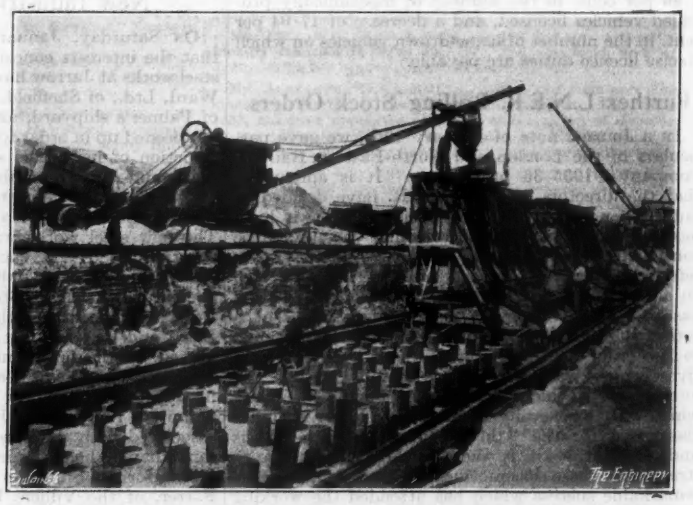


FIG. 11—CONCRETING SECTIONS OF FORT MONROE WALL

of the wall, filling the beach to about a foot above mean low water. No groins are built in front of the wall, as this beach is not a part of the ocean beach, and has not the littoral drift of sand which causes trouble in maintaining beaches along the long stretch of ocean shore. To a depth of about 25ft. the beach at Fort Monroe is composed of a variety of sands, with some quicksand pockets.

This sea wall was built in alternate blocks or sections 30ft. long, and a length of about 600ft. of wall was completed before moving to the next length. Steel forms were used and the 30ft. forms were shifted from place to place by a gantry crane running on a line of rails first used by the pile driver. To resist uplift of the wet concrete at the toe of the curved face, this part of the form was bolted temporarily to the top of the steel sheeting. Concrete for each 30ft. block was poured continuously, that for the lower part being deposited through flexible spouts or "elephant trunks." In the forms, the concrete was well spaded to prevent voids and to give a smooth and dense surface. Mechanical vibrators, placed both on the concrete and against the exterior of the forms, were used to a limited extent.

Although the foundation trench was so near the sea, no cofferdam was used, the water being kept about 5½ft. below high-tide level by means of well points. Two 6in. headers or suction pipes were laid along the sand in advance, and as the excavation advanced two rows of well points were driven to a depth of about 20ft., and were connected to the mains by flexible hose. In the seaward row, these points were about 5ft. apart, but in the landward row they were spaced 10ft. to 15ft. Each header was served by a pump driven by a petrol engine which worked continuously, day and night. A third pump was kept in reserve, and was useful when in rough weather the waves breached the dike formed by the excavated sand piled along the sea side of the trench. These breaches were quickly repaired by sand bags, and the pumps soon lowered the water to the desired level. After the piles were driven, the sand between them was dressed to the depth of about 3ft. below low-tide level and was covered with heavy roofing paper to prevent the water of the concrete from being absorbed in the sand.

In Fig. 10, the travelling pile driver, with its four sets of leads, is at the left. Beyond this a length of steel forms is being erected, and further on is another set of forms with the travelling gantry. Along each side of the work are the headers or suction pipes and the well points for drainage, served by vacuum pumps in rear of the pile driver. Fig. 11 shows the concreting of two 30ft. sections of the wall, with the line of rails carrying the pile driver and the gantry for shifting the forms.

Expansion joints between the 30ft. blocks are filled with ½in. bituminous felt, covering the entire face of the wall. As indicated in Fig. 12, the two adjacent blocks or sections are locked together by vertical and horizontal tongued-and-grooved joints, and are further held in relative position by 1in. horizontal bars or dowels, 3ft. long, coated over their entire length with ½in. of asphalt paint. Stairways provided at intervals project from the wall and are at right angles to it, as also shown in Fig. 12. However, in some similar walls the stairways are parallel with the face. Here the steps are 3ft. 6in. or 7ft. 6in. wide. They have a 7½in. rise and 11in. tread, but the riser is inclined or undercut. Galvanised 2½in. pipe sleeves are embedded in the concrete to receive 2in. pipe stanchions for the hand railing. To provide for a railing along the top of the sea wall, holes or sockets 4in. diameter and 12in. deep were cored at intervals of 60ft., and were filled with wooden plugs until such time as the hand railing should be built.

The 10ft. freeboard above high-tide level would seem sufficient to prevent waves from passing over the wall, but experience with storms has led the engineers to provide against waves that may overlap it. For this reason, back-filling is placed level with the top of the wall and extending back nearly 40ft., as shown in Fig. 9. On this is a 25ft. roadway of slag and tar, 9in. deep, built on the penetration system and rolled to a hard and smooth surface. A concrete curb is on the land side, and outside of this the fill is sloped down to the ground surface. This slope is paved with a rock revetment, finished to an even surface and having all joints filled with a bituminous composition, so as to prevent erosion or gullying by the wash of waves or spray coming over the wall.

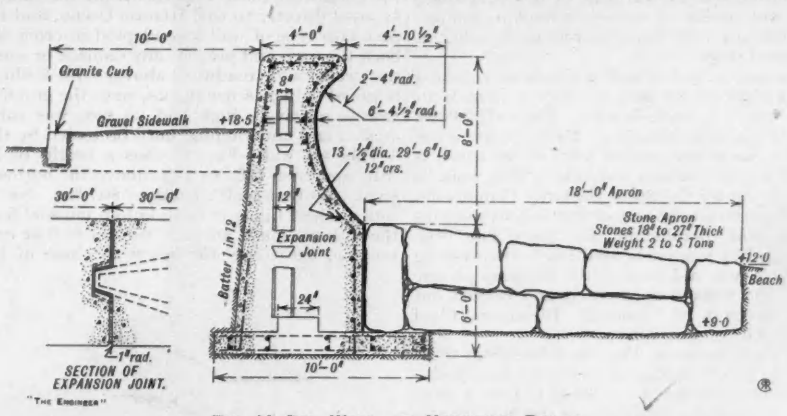


FIG. 14—SEA WALL AT HAMPTON BEACH

At its north end the Government property has to be protected against storm waters that might flow over the low ground beyond. For this purpose a timber bulkhead is built across the spit for a length of about 700ft., at right angles to the sea wall. From its inner end another bulkhead extends south 1200ft., parallel with the sea wall, but this is of lighter construction as it has only to exclude back water. Behind these bulkheads there is earth filling to an elevation of 7ft. to 12ft. above low-water level. The end of the concrete sea wall turns a right angle, and extends about 30ft. to connect with the bulkhead, thus avoiding the weak point of a corner connection.

The main bulkhead, Fig. 13, consists of timber piles, 35ft. long and about 10ft. apart, with their tops at 13ft. above low water. Behind them are two lines of 6in. by 12in. waling pieces. Against the wales are driven wooden triple-lap interlocking sheet piles, 30ft. long, each pile consisting of three 2in. by 10in. planks spiked together so as to form a 2in. tongue and groove. This sheeting is bolted through the wales and piles, as shown. The whole is capped by a double line of 2in. by 12in. planks, spiked on top of the piles and sheeting. To ensure a tight joint between the bulkhead and the concrete wall, the last pile of the steel sheeting under the wall extends to the top of the concrete, and its interlocking head protrudes from the end of the wall. To this head is connected another similar pile which is bolted through the timber wale and sheeting of the bulkhead. An alternative proposal was to use steel instead of wood sheeting for the bulkheads.

To prevent erosion by water flowing along the face of the bulkheads, loose rock revetment is placed in front. In addition, four groins of loose rock extend 100ft. from the face of the bulkhead in order to break up any waves that would flow along the face. These are shown in a detail of Fig. 9. The stonework is sunk about 3ft. in the ground and extends 2ft. above it. Behind the bulkhead, sand is filled in and covered with 12in. of broken stone, having a top course or seal of bituminous composition at about 12ft. above low tide level. This filling is nearly 30ft. wide, and then slopes down to the ground surface, the slope being protected by a 12in. layer of rock, as in the fill behind the concrete wall already described.

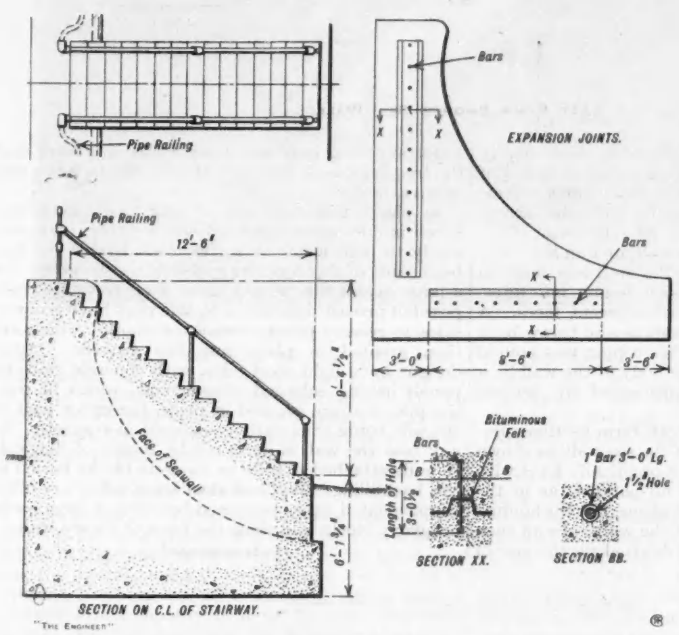


FIG. 12—DETAILS OF FORT MONROE WALL

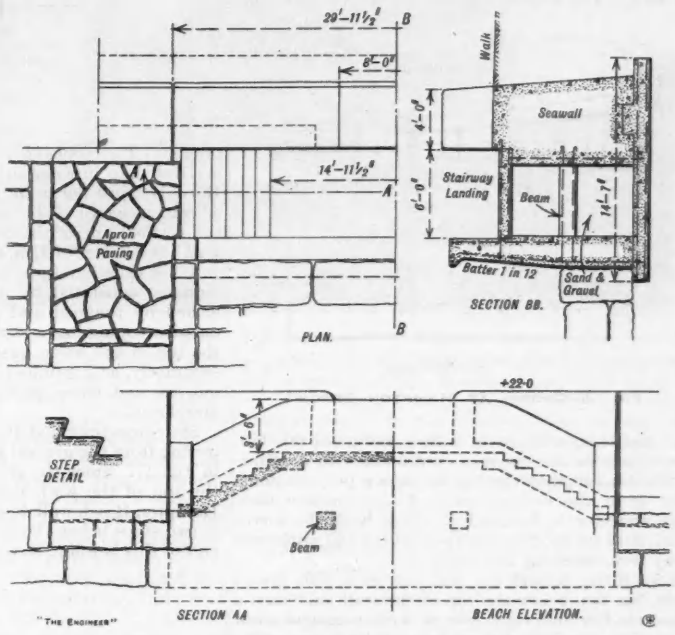


FIG. 15—STAIRWAYS OF HAMPTON BEACH WALL

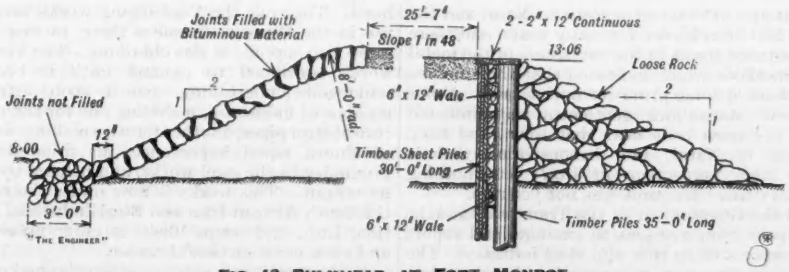


FIG. 13—BULKHEAD AT FORT MONROE

SEA WALL AT HAMPTON BEACH.

For an extensive programme of beach and shore protection in New Hampshire, on the north-east

coast, the first step was the construction, in 1934, of a concrete sea wall of the gravity type for a distance of nearly 4000ft. at Hampton Beach. This wall is at a very exposed place, bordering on the Atlantic Ocean. It is subject to wave attacks striking it directly and also obliquely from two directions, depending upon the quarter from which the wind is blowing. There is also a considerable littoral drift of the sand along this shore and groins of rockwork built in connection with the sea wall have proved their value in serving as sand traps.

On this present stretch of wall, the ends are returned or extended landward for 50ft. to prevent waves from working behind it in flank attacks. The wall follows the course of the shore line about 250ft. from the low tide contour, where the normal level of the beach is about 15ft. to 20ft. above low tide. This work is being carried out by the State Highway Commission of New Hampshire for the reason that in heavy storms a main highway parallelling the shore has been badly damaged by storms, in addition to the washing away of the beach and portions of adjacent private property. The work was designed and carried out under the direction of Daniel H. Dickinson, Chief Engineer of the Commission.

This sea wall, shown in Fig. 14, differs from those at Galveston and Fort Monroe—already described—in its pronounced overhang at the top to form a wave break. It differs from them also in the fact that its upper part forms a parapet, the filling and walk behind it being 3ft. 6in. below the top of the wall instead of being flush with the top.

No piles are used, but the foundation consists of a 12in. slab of reinforced concrete, 10ft. wide, laid directly on the levelled sand, in a trench whose bottom is 8ft. above low tide level. The wall itself is of solid or gravity section, 13ft. high, with its broad top 22ft. above low tide. Its thickness is 6ft. at the base and 4ft. at the top, with a batter of 1 in 12 for the back. The face is vertical for 6ft. up from the

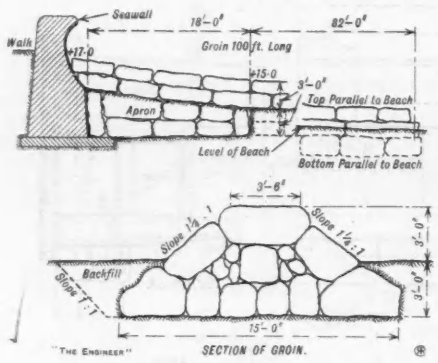


FIG. 16—GROINS AT HAMPTON BEACH.

base and is then concave, with a radius of 6ft. 6in. Near the top this curve is continued with a radius of 2ft. 4in., so that the top or coping projects some 18in. from the deepest part of the concave face. This overhang is designed to throw back the waves which rush up the face, and so prevent the water and spray from reaching the road.

Back-filling behind the wall carries a 10ft. gravel walk, 3ft. 6in. below the top of the wall, and then a broad road or highway. For protection against scour or erosion along the toe of the wall by wave action and back wash, huge quarry blocks, 2½ to 5 tons each, are placed carefully along the front of the wall and on the edge of the footing slab. These blocks form an inclined apron about 20ft. wide, the lower edge being flush with the surface of the beach.

The wall was built in sections, 30ft. long. Each section is anchored to the footing slab—to prevent sliding—by a lug or tenon 24in. by 8in. and 8in. high, and by vertical rods or dowels. The joints are ½in. wide and adjacent blocks are keyed together by a vertical tongue and groove joint which tapers in width from 8in. at the top to 12in. at the bottom of the wall. There are no horizontal dowels connecting the adjacent blocks, as in the sea wall at Fort Monroe, already described. Wooden forms were used.

Stairways provided at intervals for access to the beach are so arranged as to avoid unprotected openings in the parapet, which might allow waves to reach the road. In Fig. 15 it will be seen that a break in the parapet wall opens on to a platform or landing which forms an extension of the walk. From this landing flights of steps descend in both directions down the face of the wall to the stone apron already mentioned. At these points the joints between the apron stones are grouted to form a rude pavement to the beach. A heavy parapet well protects the stairways, as well as the landing and the opening in the parapet.

To check the continual westward drift of the beach sand along the shore, groins of rough quarry blocks are built across the beach at intervals of 400ft. to 500ft. As shown in Fig. 16, they extend to about 100ft. from the face of the sea wall and at the shore end are 2ft. high above the stone apron, the groins extending on to the curved face of the wall. Each groin is about 6ft. high, but only 3ft. above the beach surface, the lower part being in a 3ft. trench. Its top width is 3ft. 6in., with side slopes of 1 on 1½ to a base width of 15ft. The top or cap stones are required to be the full width of 3ft. 6in., and to weigh not less than 4 tons each.

LYNN-SHORES SEA WALL.

Another example of a sea wall of the gravity type is that built for the protection of the beach and water front property at Lynn-Shores, in Massachusetts, on the north-east coast. At this point the shore line is exposed directly to the Atlantic Ocean, and the concave face type of wall was adopted in order to throw back the surf, and prevent any damage or washing of the walk and roadway above. Back-filling was required only at a few points, since the ground in the rear is relatively high and its face was subject to erosion and undermining until protected by the wall.

This sea wall—Fig. 17—has a height of 16ft. to 18ft. and rises 12ft. to 14ft. above the normal beach level. Its base width is about 8ft. 6in. No foundation or sheet piling is used, but an unusual feature of the wall section is an 18in. curtain wall or cut-off at the toe, extending 4ft. below the base of the wall

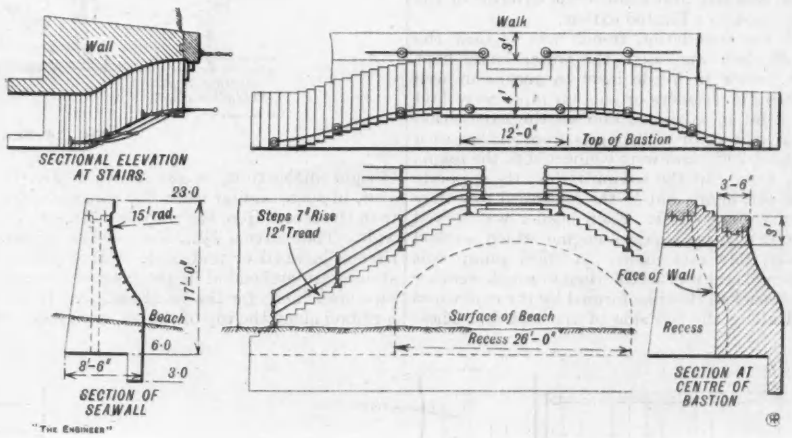


FIG. 17—LYNN-SHORES SEA WALL

proper. The concave face, which is more nearly vertical than in some other designs, has a radius of 15ft. But just below the average beach line a reverse or convex curve of 3ft. radius runs from the face to the vertical line of the cut-off wall. The rear of the wall has a batter of 1½in. to the foot, or 1 on 8.

As is usual in such cases, the wall was built in sections, separated by expansion joints, but interlocked by tongued and grooved adjacent faces. A massive coping has a slight projection to throw back the top of the wave wash. This coping was poured separately, and is united to the body of the wall by a mortice and tenon joint, supplemented by vertical dowel rods.

Stairways provided at intervals form bastions projecting from the general line of the sea wall, as shown in Fig. 17. Since the ground is practically level with the top of the wall, there is no parapet, as in the Hampton Beach wall described above, but the landing is two steps below the level of the walk. From each end of this landing, steps lead down along the face of the wall, making a slightly winding stairway as they follow the outward curve of the face. Practically the main wall is curved outward to form the stairway bastion, a recess or arched space being left under the walk in its straight course past the bastion.

BRACED VERTICAL SEA WALLS.

A development of comparatively recent years is the use of various designs of thin sea walls braced and anchored in the back filling. These walls, often termed "bulkheads," are applied both where they are exposed to direct wave action and where—at the rear of the beach—they serve mainly as retaining walls for water front property and are rarely, or never, subject to wave attack. Both concrete and steel sheet piling have been used for such sea wall construction. The ability of the vertical wall to resist wave impact and undermining depends upon the depth of penetration of the piling or other form of face; the waterproof and sand-proof tightness of the face; the efficiency of the rear support; the protection against water sweeping over and behind the structure, and the frequency and character of exposure to wave and storm attack.

In places where erosion of land fronting on the beach is due mainly to wind and weather, and only rarely to high water or waves, considerable use has been made of this concrete and steel construction. To a large extent such minor walls of concrete are composed of precast members; square piles have grooved sides to receive precast panels or planks, which are then grouted in place into the grooves. Other designs have light steel piles, with concrete slabs or panels having enlarged pilaster ends which fit over the piles and are grouted in place, the upper part of the pile being thus entirely encased in concrete. In any case the wall is anchored by means of diagonal tie rods attached to piles or concrete blocks buried in the backfilling. Walls of steel sheet piling are often supplemented by or protected by rows of large rocks or quarry blocks laid along the front of the sea wall.

(To be continued.)

The Pretoria Iron and Steel Works.

(By our South African Correspondent).

IN 1934 the Union of South Africa realised one of its foremost ambitions, when, on April 5th, the Pretoria Works of the South African Iron, Steel and Industrial Corporation started operations, and a new era in the industrial expansion of the country opened.

The existence of iron ore deposits in Natal and the Transvaal had been known for many years, and there were in existence traces of the extraction of the metal by crude methods which indicated that the smelters were members of some primitive native race. About 1906 a few Maritzburg gentlemen experimented with iron ore from beds near that town, and from other parts of Natal, and demonstrated that it carried a high percentage of iron; but nothing further was done. The time was not yet ripe.

In 1908 the Government of the Transvaal brought out an expert from overseas to examine and report on the prospects of an iron and steel industry. The results at that time were of a negative character, but research in later years established the fact that the iron ore resources of the country were far greater and more valuable than was at first believed.

Less than ten years after the Maritzburg pioneer effort a works was erected at Vereeniging, about 60 miles from Johannesburg, and with collieries close at hand, to supply some of the iron and steel products for which the enormous growth of the Transvaal gold-mining industry and the Union Railways had created a great demand. For some years this works relied for its raw material upon the huge quantities of scrap iron and steel which it was able to obtain at very reasonable prices, the main source of supply being the railways and the mines. After some years, however, the Newcastle Iron Company came into existence at Newcastle in Natal, and erected a blast-furnace which had a production of about 50,000 tons a year of pig iron, using Natal iron ore obtained close at hand. This pig the Vereeniging works was able to use in the Siemens furnaces there, to mix with the scrap iron supplies it was obtaining. The Vereeniging works continued to expand until it became an important undertaking, which soon attracted a number of industries, including one for the manufacture of steel pipes, another for wire making, and others of almost equal importance, all situated in close proximity to the steel works, and helping to consume its output. This works is now under the control of the South African Iron and Steel Industrial Corporation, Ltd., and seems likely to enter upon a larger and even more successful career.

In the meantime, another enterprise had come into existence, mainly because of the huge iron ore deposits near Pretoria. While the existence of iron ore on the Pretoria Town Lands, to the south-west of the city, had been known for a long time, it was only within recent years that systematic investigation and surveys had been carried out to prove the richness and vast content of these deposits. Experts such as Sir Robert Kotzee, the late Dr. P. A. Wagner, Professor G. H. Stanley, and others published reports demonstrating the commercial value of these ores, and that iron and steel might profitably be produced therefrom. When Dr. van der Bijl was brought from

THE PRETORIA STEEL WORKS — BLAST FURNACE, STORES AND RECOVERY PLANT

America in 1920 as Technical Adviser to the Union Government, on industrial development, he pointed out that since steel is the foundation of industry, the industrial development of South Africa could not proceed wholly on sound lines until an iron and steel industry was established.

THE PRETORIA WORKS.

Despite these favourable opinions, the suitability of the ore available, and the existence in South Africa of the fuels and fluxes for the reduction of this ore, the establishment of the iron and steel works at Pretoria has been one of constant struggles against obstacles. The apathy of a public more interested in gold and diamonds, and the difficulty of securing the ear of financial houses, militated against the earlier inception of an iron and steel industry at Pretoria. It is very possible that had the Government been satisfied with the magnitude of the iron ore deposits at Newcastle, it might have found it a sound economic proposition to have fostered the expansion of the manufacture of pig iron at that centre, and the production of steel at Vereeniging, rather than expend £5,000,000 on bringing a new works into existence at Pretoria. However, the Pretoria works was decided upon, and is now completed and in operation. Already a further sum of £3,000,000 has been made available for working capital, and additions and extensions. Out of this, a sheet works has been built, equipped, and started at a cost of about £500,000, while extensions contemplated include another blast-furnace, increase of the capacity of the heavy rolling mills, erection of a foundry, &c. Good reasons for the building of the Pretoria works were :—To render it possible commercially for South Africa to smelt her own iron and manufacture her own steel, and to produce at a price equivalent to that obtaining in the great steel manufacturing countries of the world it was necessary that the steel industry should be started on the most up-to-date lines existing there. Only by mass production and co-ordination of each process in the industry can efficiency be obtained. This has been done at the "Iscor" works, which have now entered on the production stage.

The first move in the establishment of a steel-making industry at Pretoria was largely due to the enthusiasm of a few Pretoria business men, notably the late Mr. C. F. Delfos. Sufficient interest was aroused to enable a company to be formed in 1917 with a capital of £25,000 (afterwards increased to £100,000) to prove the commercial possibility of making pig iron from South Africa's native ores, fuels and fluxes. This company, the Pretoria Iron Mines, Ltd., obtained a lease from the Pretoria Municipality and built a small 10-ton furnace, adjacent to the iron ore deposits on the Town Lands. With this furnace a quantity of over 4500 tons of good commercial iron for foundry or steel making was produced. Recognising, however, that a much larger capital was required to erect a modern works on a profitable basis, the opportunity and accepted of forming a company with an authorised capital of £1,500,000 to take over the assets of the Pretoria Iron Mines, Ltd. This new company, the South African Iron and Steel Corporation, Ltd., was formed in 1920, and during its existence bought and took options on the rich fields of hematite iron ore to the north-west of Pretoria in the Vliegpoort area, where the very rich deposit at Thabazimbi is now being mined. Coal rights were also secured on a block of farms in the Witbank district. By 1922 the capital required had not been subscribed, and in the same year the Government passed the Iron and Steel Encouragement Act, providing bounties over a number of years on iron and steel produced from South African ores.

In 1924 a Committee of four experts was invited from overseas to investigate the whole question of establishing an iron and steel industry in the Union. This investigation was very exhaustive, and the Committee's report favourable. The Corporation was, however, still unable to find the money to carry on, and eventually, as a result of negotiations, the Government took an option on the Corporation's assets. In 1928 an Act was passed to promote the development within the Union of the iron and allied industries, and for that purpose was constituted on June 5th, 1928, the South African Iron and Steel Industrial Corporation, Ltd. This undertaking is State-controlled and practically entirely financed by the State, seeing that appeals to the public to subscribe for the shares have fallen on deaf ears. The following description of the new steel works, which have arisen at Pretoria would be incomplete without reference to Dr. H. J. van der Bijl, who was appointed chairman of the Corporation, and upon whom devolved the responsibility of planning the lay-out of the works, controlling and expediting their construction, and organising the industry upon a sound economic basis.

ISCOR STEEL WORKS.

In order to appreciate the part played by each department of the South African Iron and Steel Industrial Corporation, Ltd., in the production of steel it will be simpler to follow the whole series of processes from the winning of the raw materials to the despatch of the manufactured steel products. At Iscor Works (the registered name of "Iscor" being derived from the initials of the Iron and Steel Corporation), situated some 5 miles by road in a westerly direction from the centre of the city of Pretoria, there are four principal departments :—

1. Coke oven plant.
2. Blast-furnace plant.
3. Steel furnace plant.
4. Rolling Mills plant.

Included in the main divisions there are many auxiliary sections, such as tar and other by-products recovery plant, ore and fluxing stone crushing units, blast-furnace gas cleaning plant, power-house, dolomite and lime burning plant, and workshops for maintenance and repairs. The four main departments are arranged on terraces in descending order, so that the transport of materials from one plant to the next is facilitated by gravity with a consequent economy of power. A feature of Iscor Works is the design and lay-out of the plant so as to conserve heat and energy. The works throughout provide an example of modern economical practice in this respect. One instance is the fact that at only one point in the works, namely, in the coke ovens, is coal used, and here it is only carbonised to obtain its by-products. At all other points where heat is required coke oven gas, coke breeze, waste heat from coke cooling, and blast-furnace gas are utilised. Moreover, by the recovery of many valuable by-products the smoke, which would otherwise go to waste, provides a considerable source of revenue. The industry is thus almost a smokeless one, except for certain locomotives, while even some of these are of the fireless type, drawing their heat periodically from a centralised boiler plant, which is fired with breeze screened from the coke and blast-furnace coke.

The chief raw materials of the industry are, of course, coal, iron ore, and fluxing stone (dolomite and limestone). The coals, which are purchased by the Corporation from mines in the Transvaal and Natal Provinces, are blended on arrival at the works in the proportion of 75 per cent. and 25 per cent. respectively. The inclusion of this percentage of Natal coal, after extensive experiments by Iscor, has been found to give a satisfactory blended fuel for coking.

THE COKE OVENS.

The coke oven plant comprises a battery of fifty-seven coke ovens, and considerable incidental equip-

ment. Each oven is a long narrow chamber, 36ft. 4½in. in length, 9ft. 6in. high, and 1ft. 6in. wide. The coal is first pulverised in a crushing plant to less than ⅛in. and then thoroughly blended by a screw mixer. It is then stamped into a cake in a box on the travelling charging and pushing machine. The cakes, which weigh about 12 tons each, are of the exact size required by the ovens into which they are mechanically charged. Each oven takes one of these cakes every twenty-one hours and the ovens are pushed in a predetermined sequence, such as Nos. 1, 4, 7, 10, &c., so as to maintain a uniform heat throughout the whole length of the battery.

The coal in the ovens is carbonised at a temperature of over 1000 deg. Cent., thereby driving off most of the volatiles without burning and leaving in the ovens the metallurgical coke, which is then pushed out into a dry cooling plant. The system of dry cooling which is employed not only obviates the use of large quantities of water for quenching, but extracts the heat from the incandescent coke by an inert gas to raise steam in waste heat boilers. The cooled coke, after screening, is transported by belt conveyors to the blast-furnace, which requires some 500 tons daily. The coke breeze is burned under boilers in the power station.

Extraction of By-products.

The volatiles are driven off from the coal in the process of carbonisation as gas. This gas first passes through primary coolers, causing most of the ammonia and tar to condense out in liquid form. The tar and ammonia left in the gas are subsequently removed by tar extractors and ammonia washers. The next stage is the extraction of the benzene vapours from the main stream of gas by passing it upwards through two scrubbers, from the top of which is sprayed a creosote oil which absorbs the benzene vapours. The clean gas, after treatment, is stored in a coke oven gas holder of one million cubic feet capacity, whence it is taken for use either pure or with blast-furnace gas for firing the coke ovens, the steel melting plant, and at many other points on the works where heat is required. The creosote oil (wash oil) containing the benzene is pumped to the benzole plant, where it is distilled, the benzole being thereby recovered and further purified as motor spirit.

The liquid tar and ammonia, after their condensation from the gas, are pumped together into a decantation tank, where the tar settles to the bottom while the ammoniacal liquor is taken to the ammonia concentration plant, where it is concentrated to 25 per cent. ammonia, in which state it is sold for the manufacture of nitric acid and other commercial products. During the benzole distillation there are also recovered heavy and light naphthas, which are disposed of as solvents for the paint making and other industries. The crude oil, a veritable treasure chest of valuable products awaiting extraction, is first dehydrated to free it from water and traces of ammoniacal liquor, and then distilled. This tar distillation plant consists of a still and fractionating condensers. The tar is vaporised up to the heavy anthracene oil stage, and from the vapours are condensed crude naphtha, light creosote, middle creosote, and heavy creosote, while the residue from this distillation yields anthracene oil and pitch. From the condensed tar distillates many subsidiary products are obtainable, such as naphthalene and tar acids of the phenol and cresol types. A great variety of more specialised chemicals used in medicine, explosives, dyes, &c., are not produced by the simple forms of recovery adopted by the Corporation, which are sufficient to provide the requirements of existing South African markets. From the crude tar are also distilled the several grades of road tar for surface dressing roads, grouting and the premixing of tarred macadam. Road tars are manufactured products in which control of the constituents within rigid limits is essential, the proportion of pitch, heavy oil, middle oil, &c., being regulated to give tars of suitable grades and viscosities for each type of road work, and the conditions under which they are to be used. The coke from the coke oven plant is conveyed to the blast-furnace, which is of modern type, similar to the blast-furnace erected for the Ford Motor Company at Dagenham.

Composition of Iron Ores.

Two iron ores are used, namely, Pretoria silicious hematite containing about 48 per cent. iron and up to 21 per cent. silica, mined by the Corporation in open-cast workings on the Town Lands, and a very pure hematite which averages 67·68 per cent. iron and very little silica. This latter ore is also mined by the Corporation at Thabazimbi (meaning "Mountain of Iron"), which is situated in the Rustenburg district. As the Thabazimbi ore is too pure to be smelted alone, sufficient of the Pretoria ore is mixed with it to produce the necessary slag volume. The two ores, fluxing stone, and coke are fed from the stock bunkers into a "scale" car, which runs the full length of the bunkers and delivers them into a "skip" car, which carries them by means of an inclined hoist to the top of the blast-furnace, into which they are charged. The whole of this operation is so nearly automatic that it is controlled by one man. The hot blast is supplied by turbo-blowers, the compressed air being preheated in hot blast stoves before entering the furnaces. The pig iron is taken whilst still in a molten state in 50-ton ladle carriages direct to the steel works, which lie on a terrace below the blast-furnace, for conversion into steel. Any molten pig iron, surplus to the immediate requirements of the steel melting shops, is poured into a pig casting machine, where it is cast into pigs for stock or for sale.

The slag, after being run out, is subjected to controlled cooling in large troughs, from which it is subsequently taken to a crushing and screening plant. It is in considerable demand for road metal and concrete aggregate.

The blast-furnace gas is cleaned by passage through a dust catcher and an electrical dust-precipitation plant, and is then passed to a 2,000,000 cubic foot gas holder, from which it is drawn to be used departmentally. The pig iron is discharged on arrival at the steel melting plant into the mixer, which is of the active tilting type, and is capable of holding 400 tons of metal, for partially refining before charging into the two 100-ton tilting furnaces for final refining. The mixer and steel furnaces are heated by a mixture of coke oven gas and blast-furnace gas, a producer gas plant having been installed as a standby for use in the event of temporary stoppages of the blast-furnace.

When the steel charge in the furnace is ready, it is tapped into ladles from which it is teemed into 2-ton ingots, in cast iron moulds, in which they are delivered to the rolling mills plant. Having cooled sufficiently, they are stripped from the moulds, and then, before rolling, are brought to a uniform temperature throughout in the soaking pits, which are heated by coke oven gas.

Rolling Mill Plant.

The rolling mill plant is divided into heavy and light mills. The total length of the rolling mills department building is over 2200ft. The ingots are conveyed on an ingot carriage to the heavy rolling mill, which, as its name implies, is for the production of the heavier building sections and railway material. The present range of sections to be rolled includes joists from 20 lb. to the foot up to 65 lb. to the foot (12in. by 8in.), channels from 4in. by 2in. to 12in. by 3½in., a wide range of angle, sections, and rails from 20 lb. to the yard to 96 lb. to the yard, with the sleepers and fish plates. If necessary, the partly rolled blooms may be reheated in a coke oven gas-fired reheating furnace adjacent to the shears. Special provision is made for the production of half-finished material, such as blooms, billets, and sheet bars, so as to prevent the handling of these products interfering with the normal despatch of material in the finishing shop. The rail and structural finishing department includes various straightening machines. The sleeper finishing department includes sleeper shears, sleeper pressing machines, punching machines, sleeper heating furnace and tarring plant. The light mill is to produce wire rods (minimum 0·2in. diameter), fencing standards, and merchant bars from billets supplied by the heavy mill. In addition to the many rolled steel sections produced, there are steel billets and ingots which are supplied to various concerns for the manufacture therefrom of such specialised articles as agricultural implements, steel pipes, nuts and bolts, wire, &c.

A sheet mill (see Supplement) has also been constructed, and is described later, where some 30,000 tons of sheets per annum can be rolled, much of which is for conversion into corrugated galvanised sheets of various sizes, while the establishment of a foundry is intended. The following statistics will be of interest :—

- Area of Iscor Works site, over 1000 acres.
- Length of railway track in the works, 20 miles.
- Annual amount paid in salaries and wages, £300,000.
- Number of *personnel* employed to-day, including sheet works, nearly 2500.
- Annual railage paid on coal from Witbank and Natal, £140,000.
- Annual railage paid on Thabazimbi iron ore, £80,000.
- Daily consumption of water, 2½ million gallons.
- The total installed motor horse-power is approximately 60,000, which is taken partly from the municipal power station in Pretoria and partly from Iscor's own power station, the two power stations being interconnected at 11,500 volts. Iscor's power station contains :—
- Three Yarrow water-tube boilers, each 40,000 lb. to 50,000 lb. per hour evaporation, capable of being fired from coke breeze or blast-furnace gas.
- Two Ruth's steam accumulators of capacity 31,500 lb. of steam.
- Two blast-furnace turbo-blowers, each delivering 50,000 cubic feet per minute of air at 18 lb. per square inch.
- Three turbo-alternators, each 4600 kW.
- The voltages employed around the works are 11,500, 3300, and 380, as well as 440 volts D.C.
- The total installed transforming capacity is 44,000 kW, and the converting equipment amounts to 5000 kW.

Materials Consumed by Main Departments.

Coal, 360,000 tons for coke ovens.

For Blast-furnace.

Coke, 180,000 tons.
Thabazimbi ore, 250,000 tons.
Pretoria ore, 85,000 tons
Dolomite and limestone, 90,000 tons.

For Steel Works.

Pig iron, 150,000 tons.
Thabazimbi ore, 30,000 tons.
Burnt lime, 4000 tons.
Black dolomite, 1000 tons.
Burnt dolomite, 3000 tons.
Mill scrap, 30,000 tons.

For Rolling Mills.

Steel ingots, 180,000 tons.

Materials Produced Annually by Departments.

Coke Ovens.

Coke, 180,000 tons.
Breeze, 18,000 tons.
Coke oven gas (daily), 8,000,000 cubic feet.
25 per cent. ammonia, 720,000 gallons.
Motor benzole, 630,000 gallons.
Heavy and solvent naphtha, 180,000 gallons.
Road tars, 1,750,000 gallons.
Creosote oils, 400,000 gallons.
Light oils, 180,000 gallons.

Blast-furnace Production.

Pig iron, 180,000 tons.
Slag, 90,000 tons (for road metal, macadam, and concrete aggregate).
Blast-furnace gas (daily), 100,000,000 cubic feet.

Steel Works Production.

Steel ingots, 180,000 tons.

Rolling Mills Production.

Rolled steel, 150,000 tons.
Mill scrap, 30,000 tons.

All the above figures are approximate, and will no doubt be exceeded when the whole works is working at capacity.

Sheet Rolling Mills.

The sheet rolling mills at Iscor Works comprise the following :—

- Two Lancashire boilers with one tubular fuel economiser, feed pumps, &c.
- A sheet bar shear with receiving grid and roller rack.
- One Morgan producer gas machine.
- Six combined bar and double-chamber sheet furnaces.
- A main driving gear with the necessary transformers and switchgear and the electrical equipment for the auxiliary drives.
- Six hot mill stands and two cold mill stands.
- Two double-chamber batch annealing furnaces.
- One sheet pickling plant.
- One acid storage plant, together with a Zahn regenerating plant for the spent acid.
- One galvanising plant.
- Auxiliary equipment, such as pack shears, doubling machines, annealing pots and trays, corrugating press, &c.
- Each boiler is capable of generating 6000 lb. of steam per hour at a pressure above atmosphere of 150 lb. per square inch without superheat. The site is 4500ft. above sea level. Normally, one boiler is retained as a standby unit.

All furnaces are heated with producer gas from the Morgan producer gas machine. The diameter inside the brickwork is 11ft., and the producer can gasify 2·7 tons of coal per hour, and operates efficiently at a rate of gasification as low as 1500 lb. of coal per hour. The melting point of the ash is not below 2100 deg. Fah.

The bar furnaces are of the "Costello" type, and are constructed along with double-chamber sheet furnaces in one combined steel casing. Five furnace units are of a size suitable for use with mills rolling bars up to 42in. long, while the sixth unit can operate with a mill rolling bars up to 48in. long. The fuel consumption of these furnaces equals 4 cwt. of coal per ton of finished sheets.

There are two main driving motors, each working on a three-phase, 50-cycle A.C. supply at 3500 volts and developing a normal rated output of 1200 h.p. each, when running at a speed of 440 r.p.m. The momentary overload capacity of each motor corresponds to 2750 h.p. at a speed of 440 r.p.m.

These motors drive a reduction gear of the two-stage, self-contained type, capable of giving a speed reduction of 440 to 28 r.p.m. The gear is capable of transmitting 2400 b.h.p. continuously, and of withstanding frequent momentary torques corresponding to 13,000 b.h.p. and occasional maximum momentary torques of 18,000 b.h.p. The gear is fitted with four fly-wheels with a total fly-wheel effect of 25,000 h.p. at 440 r.p.m.

The hot mill stands, two high, are suitable for taking in the first instance rolls of 30in. diameter with roll necks of 24in. diameter, but they have been so designed as to permit of 32in. diameter rolls being used. The lengths of roll barrels are 38in. and 44in., but one stand is capable of taking rolls of the necessary length for rolling sheets 48in. finished width. Each mill is supplied by one producer gas-fired combined continuous bar furnace and double-chamber sheet-heating furnace.

Each double-chamber batch annealing furnace is capable of annealing a minimum of 30 tons of sheets per twenty-four hours. When working continuously

the fuel consumption does not exceed 3 cwt. of coal per ton of annealed material.

A Vat Taylor model patent automatic steam-driven pickling machine (see Supplement), with an endless overhead runway for cradle trollies, is used. The pickling capacity of the machine, based on handling sheets 12ft. long by 36in. wide by 24-gauge, is 300 tons per day of three eight-hour shifts. The machine is also capable of dealing satisfactorily with sheets 48in. wide up to a maximum length of 12ft. and of all usual gauges. The amount of steam required for driving this machine does not exceed 500 lb. per hour at a pressure of 150 lb. per square inch.

The spent acid is regenerated by means of a Zahn plant, in which the ferrous sulphate is frozen out and finally centrifuged from the spent liquor. The sulphuric acid regenerated in this way approximately amounts to 7½ per cent. of the total quantity of sulphuric acid used per annum. Approximately 2500 tons of ferrous sulphate is produced per annum. If not sold, *e.g.*, for water treatment, it can be readily dumped.

Three continuous hot-roller type galvanising machines are used, two suitable for galvanising sheets up to 40in. wide, and the third capable of galvanising sheets up to 48in. wide. The two smaller machines are each capable of galvanising not less than 45 tons of 24-gauge sheets, 12ft. long by 40in. wide per twenty-four hours, and the larger machine galvanises not less than 54 tons per twenty-four hours of similar sheets 48in. wide. The sheets are mechanically fed into the machine, and there is no need for the operator to stand on top over the spelter bath. The galvanising unit is heated by coke oven gas, burnt in surface combination burners, while the bath is heated by impact burners, and, when not used, is kept in a molten condition by pilot burners.

The floor space occupied by the sheet mills is approximately 800ft. by 200ft. Each mill is designed to produce 8–10 tons per shift of eight hours, and when operating under normal conditions this plant will produce from 30–40,000 tons of sheets, black and galvanised, corrugated or plain, per annum, any gauge from ⅛in. downwards.

EXTENSION OF WORKS.

Already extension of the works is under consideration. Dealing with this point at the annual meeting of shareholders of the Corporation, held in June last, when Dr. H. J. van der Bijl was able to review, for the first time since the inauguration of the company, a period of production. He said that extension had been necessitated by the remarkable industrial expansion of the Witwatersrand. That expansion could not have been foreseen. The main extensions, he said, were the erection of an additional blast-furnace, the increase of the capacity of the heavy rolling mills, the installation of an inactive mixer in the melting shop, the erection of a foundry and a plate mill, and additional producing plant. He further informed the meeting that negotiations had been concluded with a Canadian firm for the establishment of a chain factory at Vereeniging. A company, the Steel Sales Company of South Africa, had been formed to assist the Corporation in the disposal of the Corporation's products and those of the United Steel Corporation (Vereeniging), and in the first nine months of its existence its turnover amounted to over £1,200,000.

PRODUCTION AND REVENUE.

The production of the Iscor Works up to December 31st, 1934 (the heavy mill did not start until September) was as follows :—

	Tons.
Coke	157,000
Pig iron	144,000
Ingots	102,000
Heavy mill	54,000
Light mill	11,000

The revenue earned from production was :

	£
46,081 tons of sections, rails, blooms, billets	409,908
3509 tons of steel ingots	14,290
13,587 tons of pig iron	49,917
5296 tons of coke	7,693
By-products	44,495

The total capital of the South African Iron and Steel Industrial Corporation is £6,500,000, including £1,500,000 debentures, and the expenditure on capital account has been about £5,400,000 on the steel works and about £500,000 on the sheet works. There has also been voted by Parliament a further sum of about £1,500,000, which will be available, if required, for the proposed extensions to be carried out, in case the public does not subscribe.

With regard to these extensions contemplated by Iscor, the latest news is that it is yet too early to give reliable details, but it is understood that the management consider that they will improve the capital position as the ratio of capital expenditure to tonnage will be reduced and so will reduce the unit cost of production.

The first period of production ended December 31st, 1934, closed with a loss of £266,022. This loss, Dr. van der Bijl explained to the annual meeting, was small when the scale of operations and the difficulties encountered were taken into consideration. In addition, a considerable portion of the loss was incurred before the whole of the plant was fully operating, and could therefore be allocated to starting expenses, and as such debited to capital account. If that had been done the loss would have been reduced, but the directors preferred not to burden the capital account in that way. For the first quarter of 1935, however, a small profit had been shown, said Dr. van der Bijl, after provision had been made for debenture interest and reserves.

The steel works has created a market in the Union for scrap iron and steel, which is smelted down at Pretoria and Vereeniging, and the subsidiary company of Iscor, with headquarters at Vereeniging, has started a shipbreaking business as an experiment. Two old ships lying in Saldanha Bay have been bought and offers, it is stated, have been made for several others, including a French coaster that was recently towed as a derelict to Durban. The chief handicap at present is the lack of proper facilities for dismantling ships, which means extra expense.

The Corporation has also made a careful study of the potentialities of a scheme for steel roads, and, it is understood, has had discussions with officials in the road department of the Provincial Administration regarding the practicability of the scheme, and that they are prepared to consider the merits of the proposals. The roads, it is claimed, would be practically everlasting. No foundation would be required and existing roads would merely be levelled and covered with grit and then covered with steel sheet about a quarter of an inch thick. The steel sheet would be asphalted and that would complete the construction of the road. According to calculation, the construction and maintenance of the proposed roads would cost less than the expenditure on ordinary main roads.

Just now the steel works is supplying large quantities of structural steel sections for the Railway Administration, in connection with the construction of railway wagons which the railways are building in their own workshops. Steel rods, which are used in the framework of the many reinforced concrete sky-scrapers, are being made from Iscor steel at the rate of about 2000 tons a month. The works is also supplying steel for the new electric generating station now being built at Klip River for the Electricity Supply Commission, as well as for the extension of the Pretoria municipal power station. The Vereeniging works of Stewarts and Lloyds Ltd., are stated to be taking 1000 tons a month of Iscor steel. This is in the form of small ingots weighing from 150 lb. to 300 lb., and is required to be of special quality for drawing into seamless steel piping. Small rails for cocopans, larger rails for the underground electric services on the Rand gold mines, and main line rails for the Railway Administration and mine sidings are now regular products of the works. There is also a constant demand for pig iron for the large number of foundries on the Rand and in Pretoria. Over 1000 tons are dispatched from Iscor each month. Iscor pig iron has made possible the production by foundries of many castings which were formerly imported.

AN OFFICIAL STATEMENT.

In face of the conflicting opinions which are being expressed, it is opportune that at this time—October 16th, 1935—a statement has been issued by Dr. H. J. van der Bijl, the chairman of the S.A. Iron, Steel and Industrial Corporation, which, although differing on some points from other statements of a more or less official nature made public during past months, is official and authoritative, and full of optimism and confidence. Dr. van der Bijl states that since July, 1935, the works has made substantial profits. All departments, including the sheet mills, which only started producing in April, 1935, have been capable of producing at rates in excess of the normal capacity. Since January, 1935, no further losses have been incurred in operation. Materials sold to the Government Railways are sold at prices at which the railways can land imported steel at the coast. In respect of the sales to the railways, therefore, the steel works do not enjoy the natural protection due to their geographical situation in the interior of the Union. Steel products of the range produced at Pretoria are not subject to customs duty when imported from Britain, while on foreign steel the duty is only 3 per cent. Since the Pretoria products came on to the market, considerable quantities of steel have been dumped from certain foreign countries, and in respect of some of these countries the existing dumping law has been applied. The dumping of steel has naturally had an adverse effect on the trading position of Iscor, but in spite of this Iscor has now reached the profit-earning stage, and its products are being very well received on the South African market. The present productive capacity of the Pretoria iron and steel works is indicated by the following portion of the statement, which gives the quantities produced during July, August, and September of this year :—

Coke, 13,700 average tons per month ; pig iron, 17,460 average tons ; ingots, 18,484 average tons ; heavy sections and rails, 16,182 average tons ; light sections, 2938 average tons ; sheets, 1836 average tons. A ton equals 2000 lb. Dr. van der Bijl concluded by saying that "considering the difficulties encountered in establishing a comprehensive works in a country to which steel-making was entirely foreign, and the short time that the works were in operation before reaching a profit-earning stage, one cannot do otherwise than regard the undertaking as very successful."

The Corporation is inviting applications for an issue of 1,500,000 "B" shares of £1 each, and the subscription list will remain open until February 12th. The purpose of this issue is to provide for additions and extensions to its Pretoria works (Transvaal), which include, *inter alia*, an additional blast-furnace, an inactive mixer in the melting shop, provision for increasing the rolling capacity of the works, and the capacity of the soaking pits and reheating furnaces, extensions to buildings, auxiliary plant and equipment generally. When the additions and extensions have been completed the output capacity of the works, with an average range of steel sections, will be approximately 235,000 tons of finished rolled products per annum. The additions and extensions will be carried out over the next two years.

105,000-kW. Turbo-Generator Set for Battersea.

No. I.

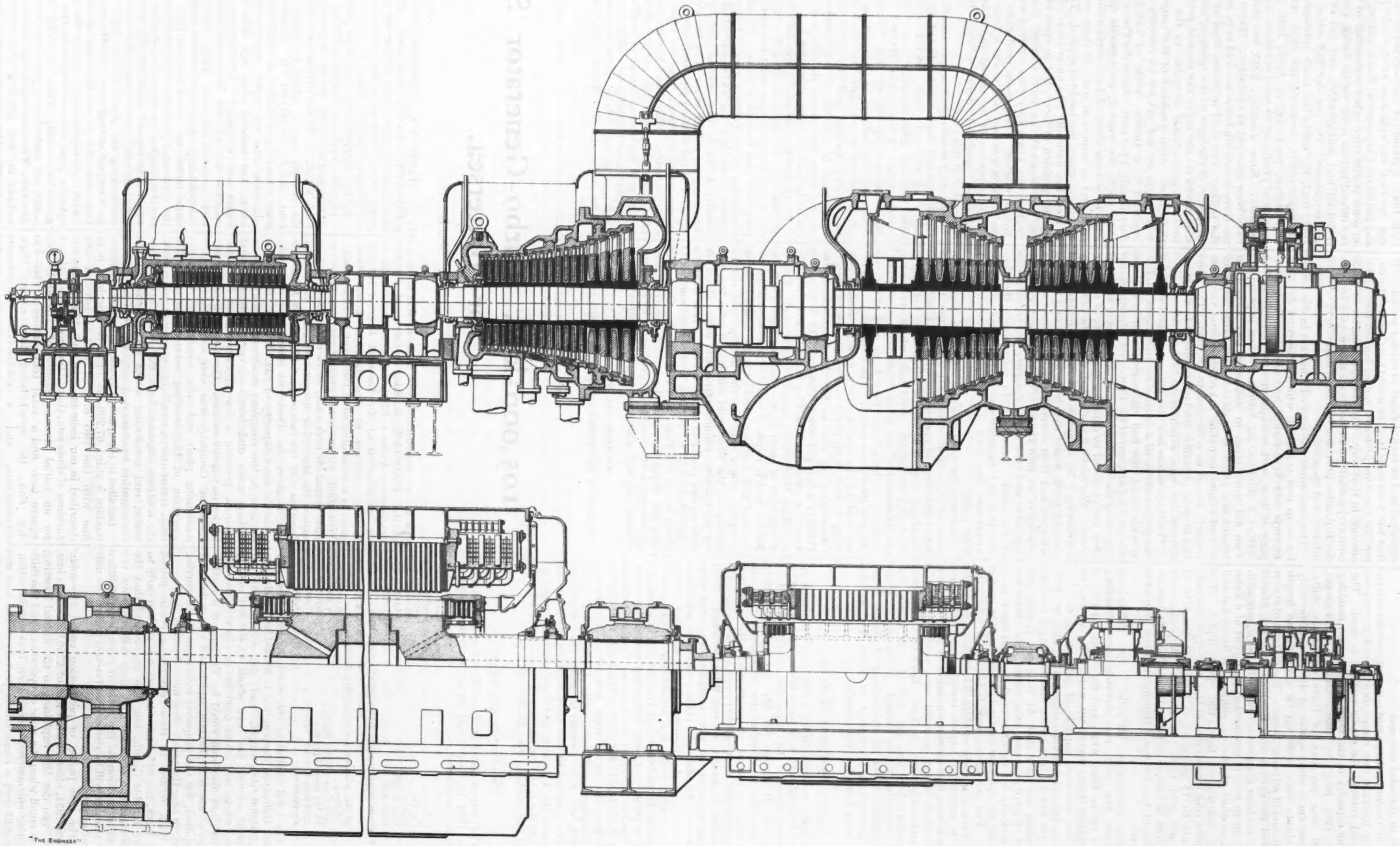
OF all turbo-generator sets built in this country, the 105,000-kW machine constructed by the Metropolitan-Vickers Electrical Company, Ltd., to the specification of Sir Leonard Pearce, for the Battersea station of the London Power Company, is outstanding from the point of view of size. With about 40 per cent. greater capacity than the next largest British unit, it is unequalled in this respect by any other machine running in Europe. Together with the two original 67,200-kW Metrovick sets, it gives the Battersea station, as it stands to-day, a total capacity of 239,400 kW. Known as set No. 3, the complete machine, comprising the turbine main and house service alternators and exciters, presents a fine appearance, as the illustration on page 99 testifies. The Metropolitan-Vickers Electrical Company was also responsible for the condensing plant and main auxiliaries. With the exception of the building contractor's work, the main transformers, auxiliary switchgear and cables, the contract extended from the boiler steam, feed water, and circulating water connections, to the main station bus-bars and outgoing feeders.

Installed in the space originally intended to accommodate a third 67,200-kW unit, the machine is in line with the two original sets, illustrated and described in our issue of June 2nd, 1933. Like the turbines of those sets, that of the new unit is designed for an initial steam pressure of 570–600 lb. per square inch and a total temperature of 800–850 deg. Fah., the speed being 1500 r.p.m. High, intermediate, and a double-flow low-pressure cylinder are coupled in line and directly connected to a 111,000-kVA, 11,000-volt main alternator, a 6250-kVA, 3000-volt house service alternator, two main exciters, and a pilot exciter, the overall length being 120ft. Sections of the turbine and alternator are given on the next page.

In the molybdenum steel high-pressure cylinder —page 99—a velocity compounded stage is followed by sixteen single-impulse stages. For loads up to 60 per cent. M.C.R., or 63,000 kW, steam is admitted before the velocity stage ; whilst for loads up to 80 per cent. M.C.R., or 84,000 kW, it enters after that stage ; loads up to the M.C.R. 105,000 kW are met by admission after the eighth impulse stage—in other words, the velocity stage and first eight impulse stages are by-passed. Diaphragms in the H.P. cylinder are of the Metrovick built-up variety with molybdenum steel plate centres, to which independently machined nozzles composed of the same metal are fitted and riveted. Spigots on the horizontal joints prevent interstage leakage and the diaphragms are supported so that they are constrained to expand concentrically with the shaft to maintain the joints steam-tight, at the same time maintaining the glands on the inner peripheries in their correct setting relative to the shaft. There are three sets of keys and keyways on each half of the individual diaphragms. Two at the sides near the cylinder joint serve to constrain the diaphragm to move horizontally, while the third on the vertical centre line confines any movement there to a vertical direction. The diaphragms can, therefore, only expand radially in their grooves. All horizontal keys are inserted after the diaphragms are in position, and are

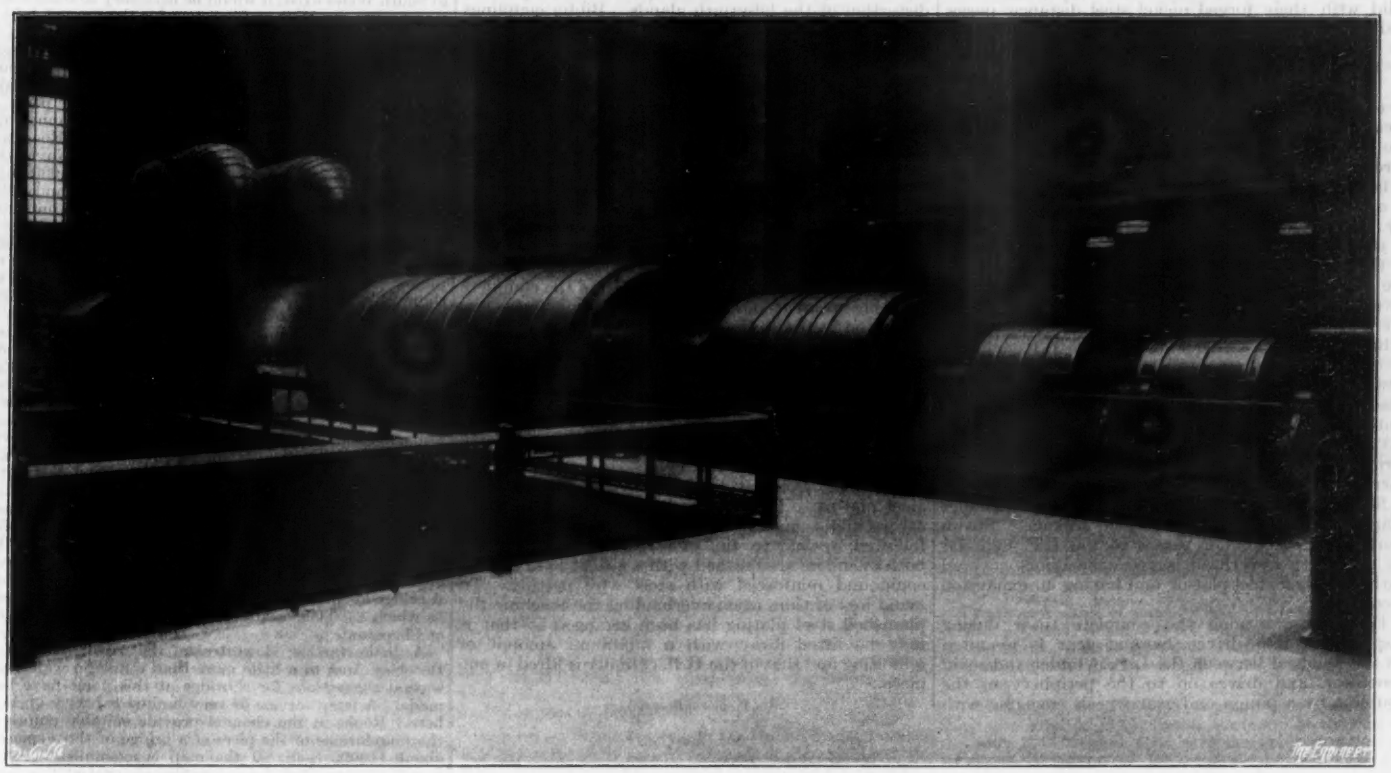
BATTERSEA POWER STATION—105,000 kW TURBINES AND ELECTRICAL UNITS

METROPOLITAN-VICKERS ELECTRICAL COMPANY, LTD., MANCHESTER, ENGINEERS



"THE ENGINEER"

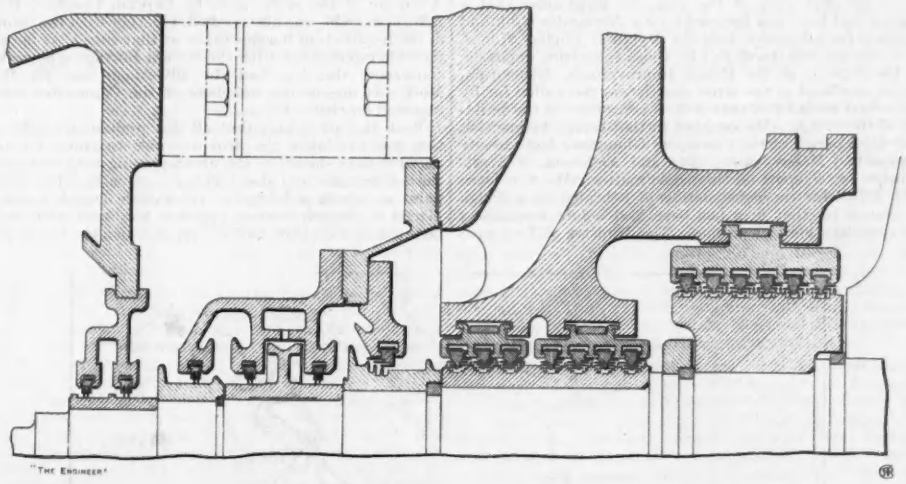
BATTERSEA POWER STATION — 105,000 kW SET



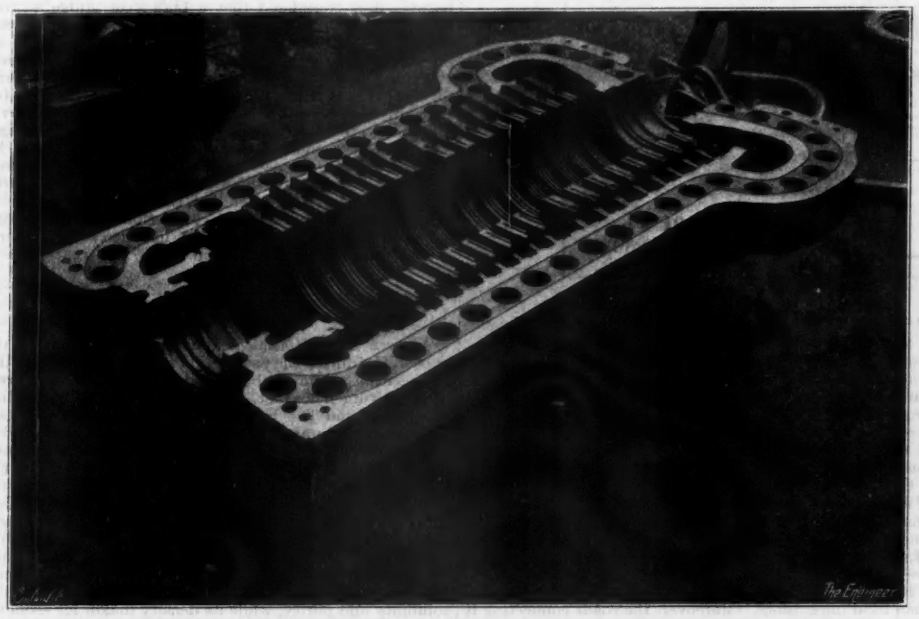
retained in place by pins inserted from the cylinder joint face. Radial clearance labyrinth packing rings at the inner diaphragm peripheries surround the shaft. Each ring is carried in a groove, and is backed by a series of flat springs, which allow the entire ring to move in the event of accidental contact.

Rotors for all three cylinders are shown on page 102 On the forged steel shaft of the H.P. rotor the rigid discs are pressed and keyed. The blades on this rotor are composed of rolled section stainless steel, with separate packing pieces. Like the blades, these packing pieces have T-shaped roots, which fit into corresponding grooves turned on the disc peripheries. Blade shrouding sections are also composed of stainless steel. At the H.P. end of the cylinder, the gland is of the radial clearance comb type, supplemented by a water seal. There are three main groups of steel comb labyrinth segment rings containing six, four, and three rings respectively, and like the other glands of the H.P. and I.P. cylinders this gland has self-clearing characteristics. If rubbing should occur the distortion due to local heating causes the clearance to increase without appreciable wear, and the gland resumes its normal setting when the rubbing is eliminated. The segment rings are carried in grooves in their respective housing and are backed in each case by a series of flat springs. Each housing is similarly carried in a groove in the cylinder casing, and backed by flat springs, so that both the rings and housings may expand relatively to the casing without changing the gland formation. Projecting ribs composed of steel sleeves on the shaft form the rotating portion of the gland. At the exhaust end of the H.P. cylinder, the gland is similar to that described and illustrated, but on account of the distance from the thrust block the segment rings are designed to permit greater axial expansion of the shaft relatively to the casing. There are three groups of rings with a total of eleven rings, supplemented by a water sealed gland.

In the I.P. cylinder—shown on page 102—there are eighteen impulse stages. The first fourteen have steel diaphragms similar to those of the H.P. cylinder, while the final four have cast iron diaphragms with cast-in-steel nozzle blades. Apart from the exhaust end portion, which is of cast iron, the cylinder itself is composed of steel. All diaphragms have spring-backed labyrinth rings on their inner peripheries. The first fourteen stages have stainless steel moving blades, with "T" roots and separate packers, while the last four stages have straddle-type nickel steel blades, with root forks fitted and riveted to the discs.



SECTION OF H.P. GLAND



TOP HALF OF H.P. CYLINDER

Steam connections between the H.P. and I.P. cylinders are carried below floor level, and consist of two U pipes in parallel. After the sixth, tenth, and fourteenth stages of the I.P. cylinder, there are annular spaces for the withdrawal of steam for feed heating. At the inlet end of this cylinder the gland is similar to that at the corresponding end of the H.P. cylinder, but fewer rings are employed and a water seal gland is incorporated. Four comb type labyrinth rings in two separate housings and a water-sealed gland, supplemented by a number of gland rings similar to those at the diaphragm centres, serve for sealing the exhaust end of this cylinder.

The double-flow L.P. cylinder, with twin exhausts for discharging into two condensers, has seven impulse stages in each flow and a duplex multi-exhaust stage. From the inlet to this cylinder and after the fourth stage, steam is diverted to additional feed-heating stages. The casing shown on page 102 is built up of ten main cast iron sections, the bottom half casing comprising eight sections. While the earlier diaphragms are of cast iron with cast-in-steel

blades, the multi-exhaust diaphragm is of welded steel construction. Moving blades in this cylinder are of the multi-fork straddled type, machined solid with their forged nickel steel distance pieces and fitted and riveted to the disc peripheries. In the final low-pressure stages, the blades are of the double-taper twisted type, tapering both in their width and in their longitudinal mid section, a form of construction which provides great root and blade strength. Low-pressure blades are laced together in groups by steel rods, threaded through and silver soldered to the blades.

In the three final stages of the I.P. cylinder and in all stages of the L.P. cylinder, means are provided for the extraction of condensation. Water present is thrown outwards into annular chambers formed in the diaphragm peripheries and arranged opposite the edges of each row of blades into which the extracted moisture cannot re-enter. The stages of the I.P. cylinder drain to the exhaust space of that cylinder and the earlier stages of the L.P. cylinder to the chamber supplying the first L.P. feed heater. Drainage from the final stages passes to the condenser space. Water seals, supplemented by several labyrinth gland rings, are provided at each end of the L.P. cylinder. The labyrinth rings consist of metal strips fixed to steel rings backed by flat springs and carried in grooves. A labyrinth ring of similar kind is fitted at the inner peripheries of the L.P. cylinder diaphragms to prevent interstage leakage. Steam from the I.P. cylinder passes to the L.P. cylinder by way of two overhead lagged connections covered with planished steel plating and having an expansion piece.

For slowly turning the complete rotor during inspection, motor-driven barring gear is mounted on the pedestal between the L.P. cylinder and main generator, and drives on to the periphery of the coupling by a pinion and gear wheels engaging with teeth formed on the coupling flange. When starting the machine all the turbine glands are sealed by a separate supply of steam desuperheated to prevent distortion of the labyrinth glands. Bibby couplings between the H.P. and I.P. spindles and between the I.P. and L.P. spindles were made by the Metropolitan-Vickers Company. That between the L.P. spindle and the generator is a semi-flexible coupling, consisting of a steel shell of corrugated section, and while possessing a certain degree of flexibility in bending, is rigid in torsion. Michell thrust bearings locate each turbine spindle relative to the casing.

The machine is located on the foundations at the generator end of the L.P. cylinder, and expansion of this and other cylinders is constrained to purely axial movement by keys and keyways on the cylinders, pedestals and guides at the pedestal bases. At economical load expansion of the complete machine from the cold condition is about 1in. measured to the H.P. inlet end pedestal. Expansion stresses in the L.P. cylinder depend upon the friction between the cylinder feet and the supporting point on the rigid part of the foundation at the I.P. cylinder end, and to ensure that these stresses are kept sufficiently low to avoid distortion rollers are provided between the cylinder feet and foundation.

Both the H.P. and I.P. cylinders are lagged with plastic magnesia and asbestos covered by planished steel plating. The H.P. cylinder has a coating of special high-temperature resisting material, 1in. thick, followed by 3in. to 4in. of magnesia lagging, while both cylinders are finished with a ½in. of hard-setting compound reinforced with steel wire netting. To avoid loss of time when overhauling the machine the planished steel plating has been arranged so that it may be lifted away with a minimum amount of unbolting and that of the H.P. cylinder is lifted in one piece.

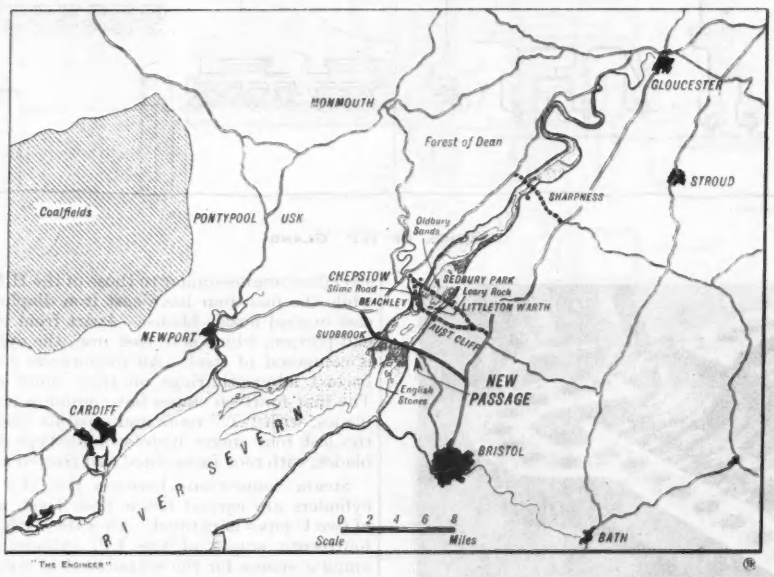
(To be continued.)

The River Severn Bridge.

IN our Annual Article on Roads, Bridges, and Tunnels in the first issue of the year, we mentioned that a scheme had been put forward by Sir Alexander Gibb and Partners for a bridge across the Severn at English Stones. That scheme was developed by those consulting engineers at the request of the Roads Improvement Association, and is unofficial in the sense that it was not called for by the actual authorities that will be concerned in the building of the bridge. We omitted in that article to mention that the Council of the County of Gloucester had already approached Messrs. Mott, Hay and Anderson, of Westminster, for a report on the whole matter. We now learn that a Bill for the construction of a bridge to a design developed by that firm has been laid before Parliament for consideration this session. The Minister of Transport has intimated that he will be prepared to make a grant of 75 per cent. towards the cost, and it is proposed that half of the remainder of the cost shall be redeemed by means of toll charges and the last portion out of local rates.

By the courtesy of Messrs. Mott, Hay and Anderson, we are enabled to describe here some of the work which was necessary as a preliminary to the choosing of a site for the bridge and to the estimating of its cost. In examining the four sites shown on the accompanying map, the engineers were careful to consult all the authorities which might be affected in any way by its erection and to examine previously collected data as to the state of the foundations to be expected in the river bed, and as to the nature of sand banks, &c., which might be disturbed by scour from the piers. Among others consulted were the Gloucester Harbour Trustees and Pilotage Board, the Sharpness Docks Company, the Severn Catchment Board, and the Commissioners of Sewers Lower Level of Gloucestershire. A survey of the river made by Captain Beechey, R.N., F.R.S., in 1846, was also studied, together with the records of the hundreds of borings taken at that time. As far as a possible interference with the Severn Barrage scheme was concerned, the firm had the advantage that Sir Basil Mott was one of the members of the Committee which reported on that scheme.

With the advantage that all this preliminary information was available, the firm was able to study the four possible sites shown on the accompanyng map and assess the advantages and disadvantages of each. The lowest point at which a bridge of practicable length could be placed is English Stones, opposite Sudbrook and nearly 30 miles by road from Gloucester, at which the lowest road bridge is at present situated. On the Welsh bank of the river are situated the important industrial centres of Cardiff, Newport, Pontypool, and the Forest of Dean, while on the English side there are Bristol, Bath, and Stroud. As a glance at the map will show, the building of a bridge would very much reduce the distance by road between these centres.



SUGGESTED SITES FOR SEVERN BRIDGE

One suitable site for a bridge is situated about a quarter of a mile above the existing L.M.S. and G.W.R. bridge at Sharpness. A bridge here would be about one mile long, and would cost, it is estimated, inclusive of all charges, about £1,400,000. But although foundations and local conditions are suitable for the construction of a bridge at this site, it is hardly far enough down the river to make it of more than local importance. Moreover, the roads connecting it to London pass over hilly ground rising sharply to 800ft., and with increased traffic resulting from the construction of the bridge considerable and expensive improvements to the roads would need to be made. On the north-western side, although suitable roads connecting the site to South Wales exist, it would be necessary to build a new bridge over the Wye at Chepstow for the present bridge, is hardly adequate to bear the traffic it now takes.

The site at Sedbury Park–Littleton Warth is more satisfactory in producing a connection between the South of England and South and Mid Wales. The bridge would have a length of about 2¼ miles. At this point, as will be seen from the map, the navigation channel runs close to the north-west bank, is known as Slime Road, and has a width at low water of about 1400ft. Navigation interests would require a span of 1200ft. to 1400ft. over the channel with a clearance between 100ft. and 120ft. The chief objection to this site lies in the fact that numerous piers would need to be founded on Oldbury Sands. Although rock is to be found here at depths from 16ft. 6in. to 22ft. 9in. below the surface of the Sands towards the middle of the river, Captain Beechey's borings of 1846 show only sand towards each bank. It is, however, believed that rock would be encountered everywhere at depths not greater than 65ft. Under these conditions it is difficult to estimate what the construction of a bridge would cost without taking many more borings. Moreover, the erection of about forty piers on the Sands, although probably perfectly feasible from the engineering point of view, might, it is feared, set up scour and so cause a change in the location of the sands themselves. Although Oldbury Sands appear to be stable enough, it is a fact that further upstream surveys of the bed of the river have had to be abandoned on account of the shifting nature of the sands. If the Sands should shift expensive remedial works might become necessary in order to stabilise the present navigational channel. Approaches to the bridge offer no difficulties except that it would be of even greater importance to build a new bridge at Chepstow. A bridge at this site would cost about £2,400,000, inclusive to which £300,000 would need to be added for the work at Chepstow.

A little further downstream the river narrows at Beachley-Aust to a little more than a mile in width, and several suggestions for a bridge at this point have been made. A ferry service of very limited capacity operates here. Rocks in the channel provide suitable points for the foundations of the piers of a bridge of three spans of about 1100ft. each. If the map is examined, however, it will be seen that the navigation channel at this point makes a very sharp turn to the left. This, in combination with a tide which, off Aust Cliff, may attain a maximum speed of 6½ knots, imposes difficulties on navigation to which navigation authorities do not wish to add by allowing piers to be situated in the river. It would therefore be necessary to adopt the expensive expedient of a 4000ft. span and a clearance above high water of 100ft. to 120ft. Together with the building of a new bridge at Chepstow the cost of this structure, together with approach roads and all subsidiary costs, would be as much as £6,050,000 it is estimated. If it were found possible to erect three separate spans the cost would be only £2,800,000.

The lowermost site of all at Sudbrook-New Passage, over the English Stones, is regarded as the most preferable. A bridge here would have a length of 3800 yards and one span of about 1400ft. over the navigation channel which, at this point, is known as the "Shoots," and has a minimum width of 900ft. Except for the navigation channel the remainder of the bed of the river dries out at low water and affords good foundations of sandstone and marl for the foundations of a bridge. As far as approach roads are concerned there are no special difficulties, and the site being below the mouth of the Wye it would not at present be necessary to build a new bridge at Chepstow. The estimated cost, inclusive of all charges as before, is £2,480,000.

All the bridges considered would have carriageways 30ft. wide between kerbs and a 6ft. footpath on each side, while approach roads of the twin variety, with 20ft. carriageways, would be built. It is assumed that land 100ft. between fences would be bought.

The Bill which is to be placed before Parliament is based upon the scheme for a bridge at English Stones. It is just at this point that the Severn Barrage may at some future date be built. The scheme for the barrage ncluded the provision of road and rail connections at a low level across the river. But unless the Government has any immediate intention of proceeding with the barrage it is considered that a high-level bridge at this point need in no way interfere with the ultimate construction of the barrage at a later date, and, in addition, might affect economies in the erection of that structure owing to the absence of the low-level road. In estimating for the cost of the bridge allowance has been made for such precautions as the sinking of foundations to a level low enough to be unaffected by later work on the barrage. The respective ends of the bridge as planned would be connected by new roads to the Gloucester–Cardiff and Gloucester–Bristol roads on the north-west and south-east respectively, while should the Bill become law it seems probable that a direct connection from the bridge to the London–Bath road at, for instance, Chippenham, would come under consideration.

A NOTE in the *Chemical Trade Journal* says that the appearance during the past year of a new natural asphaltite of Argentine origin has been one of the features of interest in the bitumen market. It possesses highly individual properties, and has been proved by analysis and tests to be the natural asphaltite available to the market most nearly corresponding to the product, now extinct, formerly known as Trinidad Manjak. For use in the plastic moulding industry, an exceptionally high melting point of about 180 deg. Cent., drop-point about 420 deg. Fah., wide plastic range, good insulating qualities, acid resistance, and low water absorption, are outstanding points. In ink and varnish manufacture, especially where insulation or resistance to heat, weather, and acid is desired, the above qualities are combined with high solubility and purity, while its density makes for economy by reason of the high proportion of low cost "thinners" which it can stand.

Rail and Road.

AT a meeting of local authorities of the Metropolis, held at Westminster on January 9th, as a result of negotiations with the Ministry of Transport, it was agreed that the authorities take over the pedestrian crossings as from April 1st, 1936. This will involve the authorities shouldering the responsibility for over 40 per cent. of the cost of maintenance and refunding 40 per cent. of the cost of installation. It was also decided that additional police supervision was necessary at important points, and urged that the Minister should take steps to ensure better observance of the regulations.

ADDITIONALLY to the case of the driver of the mail train concerned in the Shrivenham accident of January 15th, there have since been two other accidents involving the deaths of railway servants. The more serious of these happened to a ballast train at Barkston, 4 miles north of Grantham, which was run into by two light engines coupled together, and six of the men on the ballast train, who were riding in the van at the rear, were killed. The inquest was opened on Tuesday, the 21st, but, after evidence as to identification, it was adjourned until February 17th. On Tuesday, the 21st, the guard of a goods train, the rear portion of which had broken loose, was killed on the L.M.S.R., when a following goods train ran into the detached portion.

THE Ministry of Transport inquiry into the collision of January 15th between the mail train from Penzance and a mineral train at Shrivenham, between Swindon and Didcot, when a passenger and the driver of the mail train were killed, was held by Colonel Mount on Tuesday, the 21st. The accident was caused by the failure of a draw-bar hook, which resulted in the brake van and the next five wagons becoming detached and, for reasons that Colonel Mount heard in camera, the mail train was admitted into the section that was occupied by the vehicles that had become detached. The failure of the draw-bar hook, according to Mr. C. B. Collett, was caused by a defect which could not have been noticed under normal inspection. Mr. Collett said that the brunt of the collision was taken by the steel underframe of the second coach—a brake van carrying newspapers only—the body of which was left practically intact. The body of the front coach was detached from the underframe and rolled down the bank. A very unusual effect was that five doors on one side and four on the other could afterwards be freely opened. After this and other evidence as to the effect of the collision had been given, the remainder, as said above, was heard in private.

IF it should be shown that the fatal derailment of January 15th at Shrivenham, Great Western Railway, referred to in greater detail in another paragraph, was the result of the rear portion of an up freight train having broken loose as the consequence of a defective wagon coupling, the mail from Penzance having run into the detached brake van and wagons, it may be useful to know that the failures of couplings number some 5000 a year. During the year 1934 there were 4679 such failures, of which 3429 were of wagons and of the latter figure 1094 were the fractures of couplings and 2335 the failures of draw-bars or hooks. Of the total number of failures of couplings, 875 were in coaching stock and of this total of 4679, 1461 occurred whilst the train concerned was running. The Great Western has always enjoyed a good record as to the failures of couplings. Of the 4679 in 1934 they had only 219, as compared with 1289 for the L.N.E.R., 1156 for the L.M.S.R., and 240 for the Southern. Attention to that fact was drawn by the author of "Railway Accidents: Legislation and Statistics, 1825 to 1924," wherein, at page 25, he said that he "has always been impressed by the fact that the Great Western reports fewer failures comparatively than the other large companies, especially as regards couplings. That fact is made evident in Table II. It suggests either that the company does not report as strictly as other companies or that its equipment is better maintained. The author is satisfied that the explanation lies in the latter fact, and his view finds some corroboration in the Midland Company's figures before that company was grouped. It is well known that the latter company had a fine upkeep."

THE anniversaries of two serious accidents occur at about this time. The third of the three serious railway disasters near the Christmas of 1910 was at Coke Ovens signal-box, Pontypridd, Taff Vale Railway, on January 23rd, 1911. A mineral train stood within the view of the signalman concerned and yet he admitted a passenger train into the same section and eleven passengers and the guard of the mineral train were killed. Colonel Druitt inquired into the case and the outstanding features of his report were:—A recommendation as to the substitution of three-position for the then two-position block instruments; the serious telescoping of vehicles on the passenger train; the objection to inspectors visiting signal-boxes and questioning signalmen, whilst they were engaged in their signalling duties, as to delays to trains; the working of Rule 55, especially in places like this, where it was dangerous for firemen to cross many lines on their way to the box. The other serious accident was that of January 26th, 1921, at Abermule, Cambrian Railway, when two trains met head-on on a single line and eleven passengers and three servants were killed. The line was controlled by the electrical tablet and the disaster would not have occurred but for irregularities by three men. A train arrived at Abermule from Montgomery with a Montgomery-Abermule tablet. The driver should then have been given an Abermule-Newtown tablet, provided that that section was clear. It was not, however, clear, as a train was on its way from Newtown and its possession of a Newtown-Abermule tablet physically closed the line against an opposing tablet. The porter who took the Montgomery tablet told the stationmaster to change it, but the stationmaster, instead, took it direct to the train without passing it through the instrument and thus getting, or attempting to get, the permission of the Newtown signalman. Neither the driver nor fireman obeyed the rule as to inspecting the naming on the tablet before accepting it, and finally the signalman did not question the intimation of a young porter that the train from Montgomery was to go on.

Miscellanea.

IT is estimated that the revenue from the Mersey Tunnel for the year ending March 31st next will be some £256,000.

ORDERS to the value of £72,000 for railway material have recently been placed in this country by the Dominion of New Zealand.

THE election by the board of directors of Mr. H. J. Mitchell as president of Imperial Chemical Industries, Ltd., is announced.

THE estimated number of applications for patents for inventions in 1935, according to Gee and Co., was 36,100, as compared with 37,409 in 1934.

CONSTRUCTION has begun on the Megna Bridge on the Assam Bengal Railway. When finished the bridge will consist of seven 323ft. spans and six approach spans of 100ft.

SATISFACTORY trials have been carried out in Norway for the production of sodium nitrate with the aid of sea water instead of sodium carbonate. A new factory working on the process has been put into operation.

THE Council of the Institution of Electrical Engineers has elected Sir John F. C. Snell to be an Honorary Member of the Institution. It is also announced that the Council has made the fourteenth award of the Faraday Medal to Sir William H. Bragg.

A NUMBER of tests in various mines and quarries in the United States to compare the costs and operating performance between detachable and forged drill bits in rock drilling have shown that detachable bits give greater economy in use.

ACCORDING to the annual list of company registrations issued by Jordan and Sons, Ltd., during 1935 there were registered 115 aviation companies with a total capital of £5,121,290; 513 electricity, gas, and water companies with £2,514,620; 728 engineering companies with £6,610,924, and 195 mining and quarrying companies with a total capital of £14,050,800.

ACCORDING to the Director of the United States Bureau of Mines between 60 and 70 per cent. of the entire wealth of the United States has its origin in the mineral industries. He said that in normal times at least a million men work in mines and quarries, and the mineral industries give direct employment to 1,700,000, some 800,000 of them actually working underground.

FIGURES issued by the Minister of Transport show that the gross amount received in payment for licences issued during the twelve months ended November 30th, 1935, was £30,480,176, compared with £32,587,589 in the corresponding period of the previous year. The total number of motor vehicles, excluding tramcars and vehicles requiring trade licences, was approximately 2,336,722, compared with 2,116,582 in the corresponding period of the previous year.

AT an informal meeting of the Institution of Electrical Engineers held on January 6th, a discussion took place on "Sound Recording and Reproduction." It was pointed out that from this branch of engineering a new kind of engineer had developed with electrical, mechanical, acoustical, chemical, and in some cases civil characteristics. A great deal was made of the very different standards of audibility and of the adulteration of sound tolerated by the layman and investigator, while the criteria of sound reproduction and the forty or so factors of distortion were dealt with at length.

THE annual report of the United States Secretary of the Interior says that the Boulder Dam has already prevented one menacing flood in the Imperial Valley of California. Shortly after the gates of the dam were closed, according to the report, a flood level flow of 105,000 cubic feet per second of water raged in the Colorado above the dam. Had this water passed on, the Imperial Valley would have been menaced. Instead, the waters began filling up the 115-mile long lake and reservoir above the dam. The report adds that the Boulder Dam will make impossible a repetition of the 1934 disastrous drought in the Imperial Valley, which cost the region over 10,000,000 dollars.

THE Marconi School of Wireless Communication at Chelmsford is a training centre for advanced instruction in experimental and practical wireless, and was established in 1901. For the past fifteen years it has occupied premises known as Chelmsford College at Arbour-lane, Chelmsford, but owing to the increased demand on its services, it is to be transferred in the near future to a new and larger building to be erected in the same grounds at Arbour-lane. It will be equipped with the latest apparatus to meet all the requirements for practical instruction in modern wireless technique in every branch of its manifold development. The residential accommodation is also being extended. The architect retained by the Marconi Company for the constructional work is Mr. W. W. Wood, F.R.I.B.A., M.I. Struct. E., of London and Chelmsford.

A NOTE in *Engineering News-Record* says that a multiple arch dam, about 3300ft. long, located near Magnitogorsk, in the Ural Mountains in U.S.S.R., may be subjected to the thrust of a sheet of ice, about 5ft. 6in. thick, producing a pressure on the face of the dam of 4600 lb. per square foot. To relieve the dam of this critical stress, a compressed air system has been installed to prevent the formation of ice at the crest of the dam. The installation consisted of a 1¼in. perforated pipe line laid at a depth of about 10ft. near the upstream face of the dam and along its entire length. The perforations, 0·04in. in diameter, were spaced about 10ft. apart. Compressed air was supplied at the rate of about 13,000 cubic feet per minute by compressor plants at each end of the pipe line. Operating this installation for a period of four to eight hours in twenty-four hours made possible the maintenance of a strip of open water, free of ice, along the crest of the dam even at temperatures of 22 deg. below zero (Fahrenheit). Between operating periods, a sheet of ice 2in. to 4in. thick might form at the dam crest. This can be entirely removed by running the compressed air plant for a short period.

Air and Water.

THE Bibby liner "Gloucestershire" has been sold for breaking up.

IT has been decided by the Luton Council to purchase a 300-acre site for a municipal airport.

ONE of the two cruisers included in the 1933 programme, H.M.S. "Southampton," is to be launched at Clydebank on March 10th.

IT is reported that the United States Navy Department has ordered 114 bombing machines from the Douglas Aircraft Company.

WORK on clearing the ground for the third Royal Air Force aerodrome at Singapore is to be begun in April next. The principal depôt at Seletar is also being extended.

FIGURES of Suez Canal traffic for 1935 show that the number of transits was 5992, or an increase of 329 over the 1934 total. Receipts amounted to 887,720,000f., compared with 856,410f. in 1934.

GOVERNMENT sanction has been given to the Rhyl Urban District Council for a scheme for the diversion northwards of the mouth of the river Clwyd in order to safeguard the foreshore and sea wall.

FLYING a Northrup monoplane, Mr. H. Hughes has flown the distance of 2450 miles between Burbank, California, and Newark, New Jersey, in 9 hours 27 minutes, thus making a new transcontinental flying record.

AN official announcement has been made that the United States Department of Commerce is to accept a contract submitted by the United States Lines for the construction of a new liner with the aid of a Government loan.

THREE new ships of some 12,000 tons each have been ordered by the Royal Packet Steamship Company of Amsterdam for their China–Java–Mauritius–Africa service. Two of the vessels will be built in Holland and one in Germany.

DURING 1935 Swedish shipyards launched twenty-two ships of a total of 195,829 gross tons, and at the end of the year 206,000 gross tons were under construction or on order. Thirteen of the vessels launched were for Swedish owners and nine for foreign owners.

THREE vessels are to be employed on a monthly cargo service to be instituted in March by the Nippon Yusen Kaisha between ports in Japan and Brisbane, Sydney, Melbourne, and Adelaide *vid* the Pacific Islands (Mandated Territories). The first sailing is to be made from Yokohama on March 22nd.

INQUIRING into the deaths of the eleven occupants of the Belgian air liner which crashed at Tatsfield on the evening of December 10th last, a coroner's jury returned a verdict of accidental death caused by an error of judgment on the part of the pilot owing to abnormal weather conditions. It was added that no blame was attached to the pilot.

THERE are forty-seven cargo-carrying vessels of over 8000 tons deadweight carrying capacity at present under construction in this country, of which eleven are being built on the Clyde and thirty-one on the North-East Coast. Nineteen of these vessels will be motorships, the remaining twenty-eight having steam-propelling machinery of various types.

THE directors of National Shipbuilders' Security, Ltd., have accepted the offer of Harland and Wolff, Ltd., for the purchase of the ship-repairing business and graving dock of D. and W. Henderson and Co., Ltd., at Meadowside, on the Clyde. The shipbuilding yard, which has not been sold, will still be kept by National Shipbuilders' Security, Ltd., on a care and maintenance basis.

ACCORDING to the quarterly return of the Chamber of Shipping, as compared with the amount in January, 1935, there has been a decrease of 452,654 net tons, or 51·5 per cent., in the amount of laid-up tonnage in British ports. Idle tonnage in the ports of Great Britain and Ireland on January 1st amounted to 186 vessels of 425,762 net tons, of which seven are foreign ships of 12,381 net tons.

THE annual review of hydro-electric progress in Canada, prepared by the Dominion Water Power and Hydrometric Bureau of the Department of the Interior, discloses a substantial addition to the total developed water power capacity in the Dominion during 1935. New installations, aggregating 362,080 h.p., were completed and made ready for operation, thereby bringing the total for the Dominion at the end of the year to 7,909,115 h.p.

A LIGHT aeroplane known as the "Praga E 114" is to be manufactured in this country and called the "Hillson Praga," according to *Flight*. The machine is a cantilever, high-wing monoplane mainly of wood and plywood construction. Fitted with a "Praga B" flat twin engine of 40 h.p., it has a top speed of 93·3 m.p.h. and a cruising speed of 79·6 m.p.h. A "Pobjoy Cataract" engine can be fitted which gives the machine a top speed of 115 m.p.h. and a cruising speed of 98·3 m.p.h.

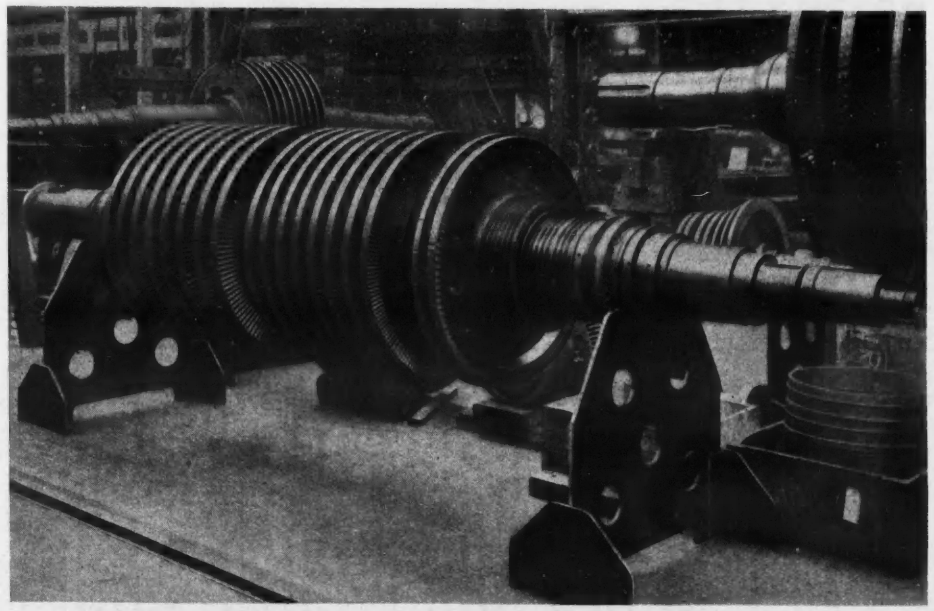
AN Admiralty announcement states that the following decision has been made in regard to the status of the non-magnetic ship "Research," which is to be built for the Admiralty to carry out the work of research on magnetic variation previously undertaken by the s.s "Carnegie." She is to be known as the Royal Research Ship "Research" (R.R.S. "Research"), and to be given a mercantile status. The crew will be entered on the ordinary mercantile articles, as are the crews of Royal Fleet Auxiliaries.

REPRESENTATIVES of more than sixty organisations interested in the ownership and operation of aerodromes will attend the conference of the Aerodrome Owners' Association, which will be held at British Industries House, London, on January 30th and 31st. There has been a great demand for space for the exhibition of airport equipment which is to be held in conjunction with the conference, and the products of some seventy-five firms will be shown. The conference will be officially opened by Lord Swinton, Secretary of State for Air.

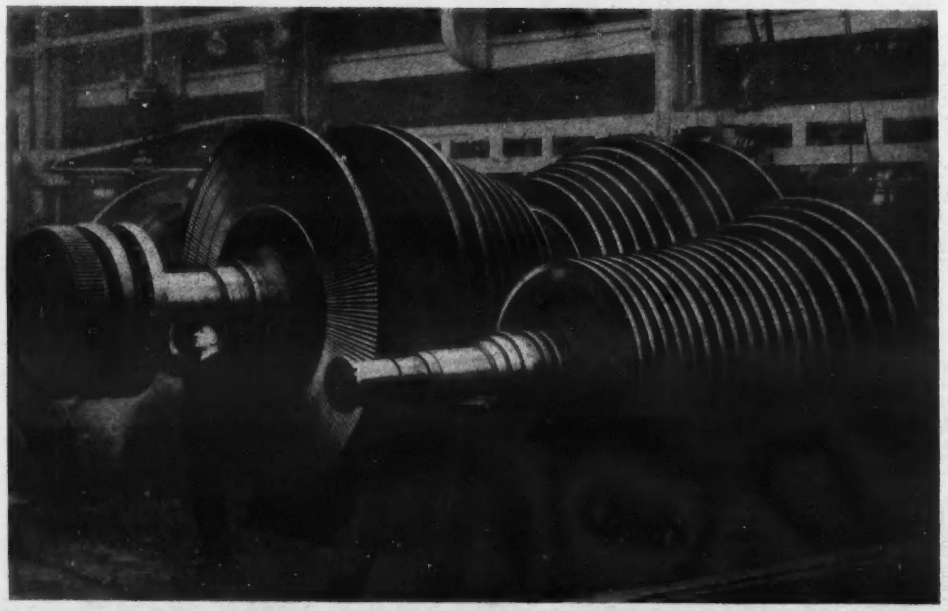
BATTERSEA POWER STATION — PARTS OF 105,000 kW TURBINES

METROPOLITAN - VICKERS ELECTRICAL COMPANY, LTD., MANCHESTER, ENGINEERS

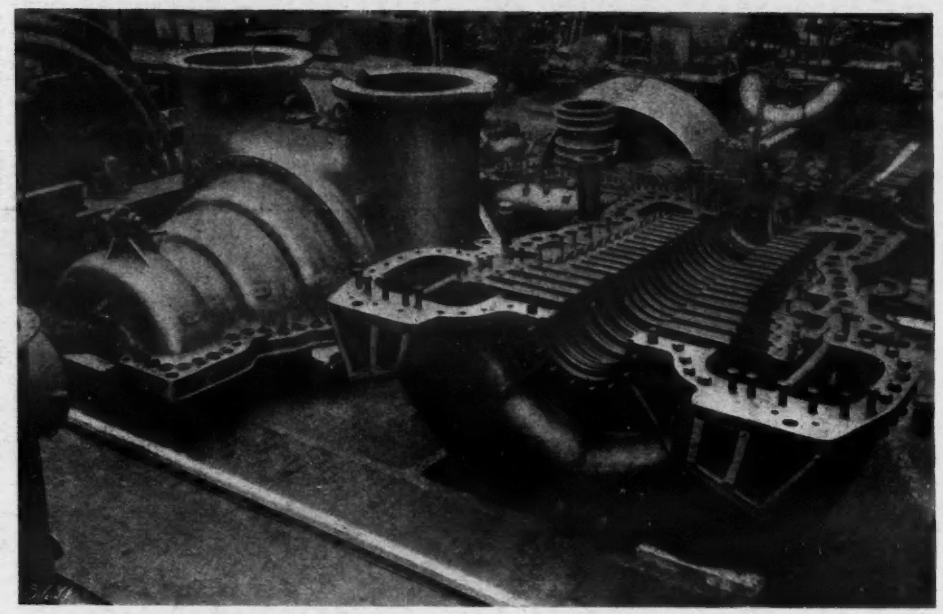
(*For description see page 97.*)

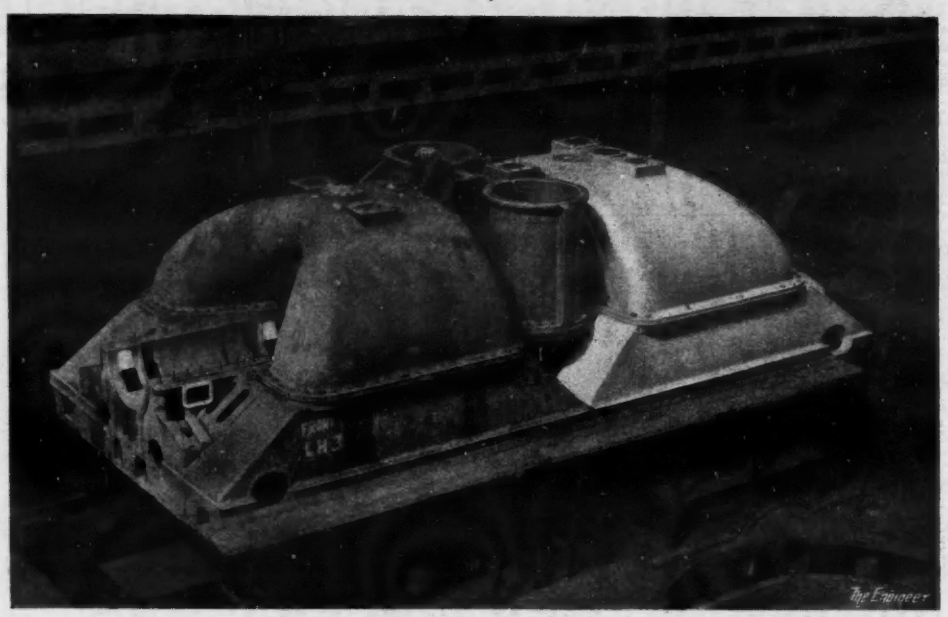


H.P. ROTOR
TOP AND BOTTOM HALVES OF I.P. CYLINDER

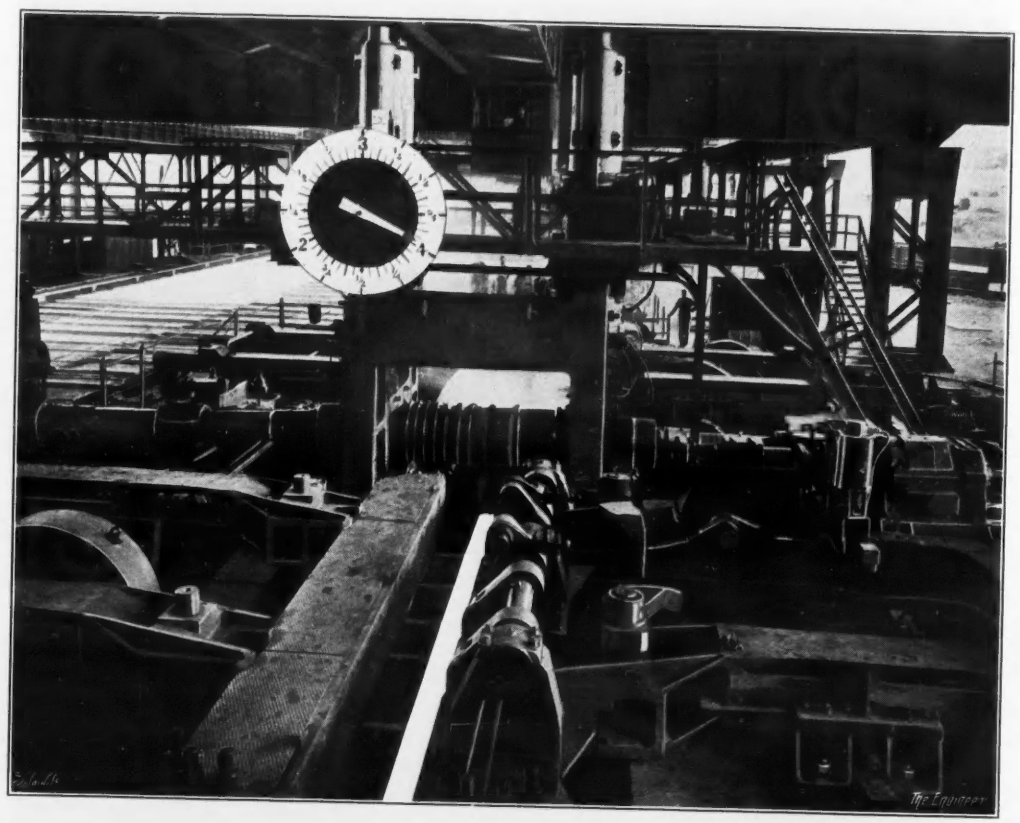


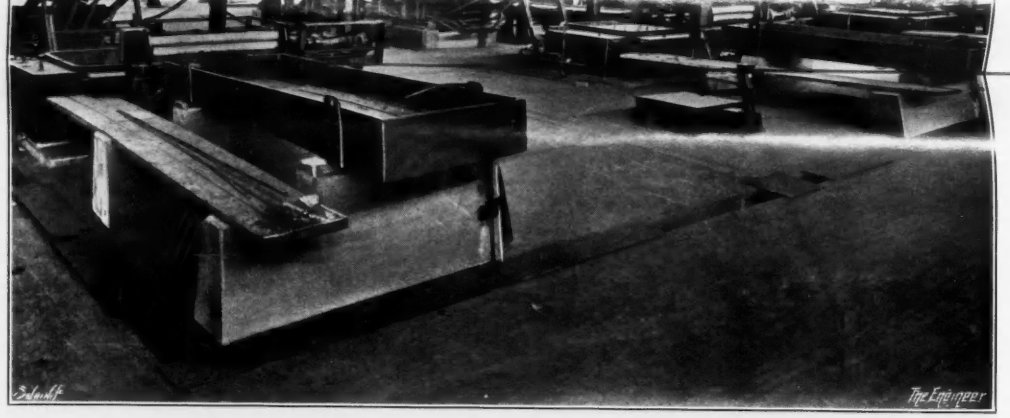
I.P. AND L.P. ROTORS
L.P. CYLINDER

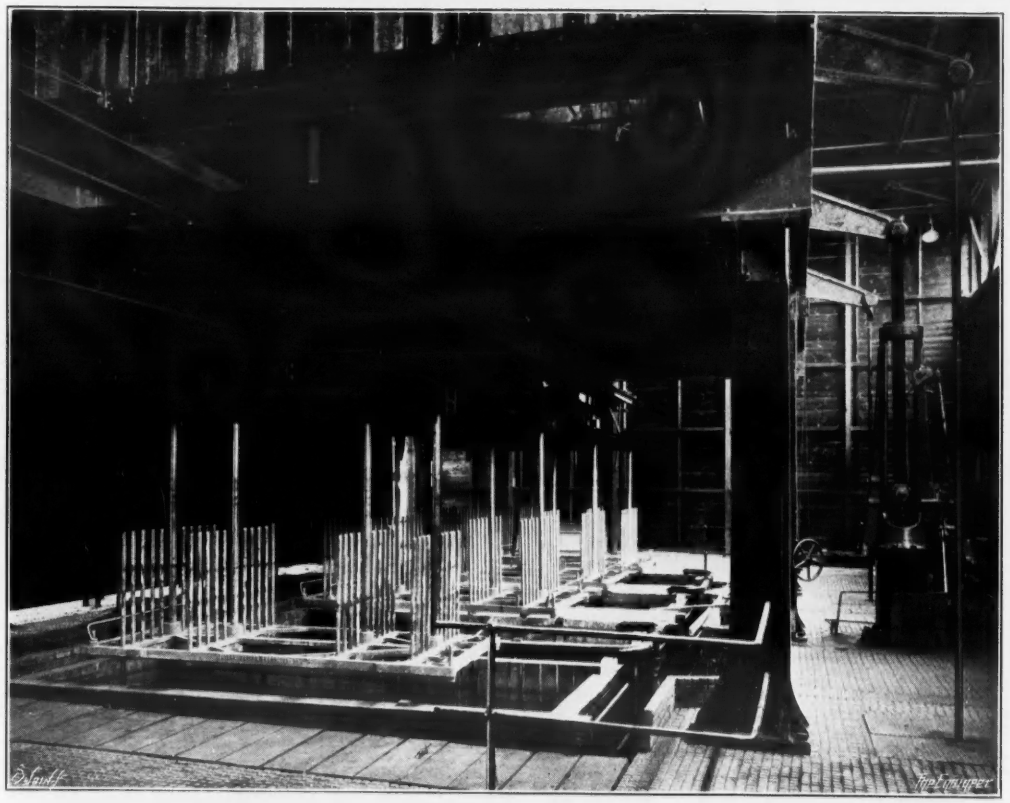


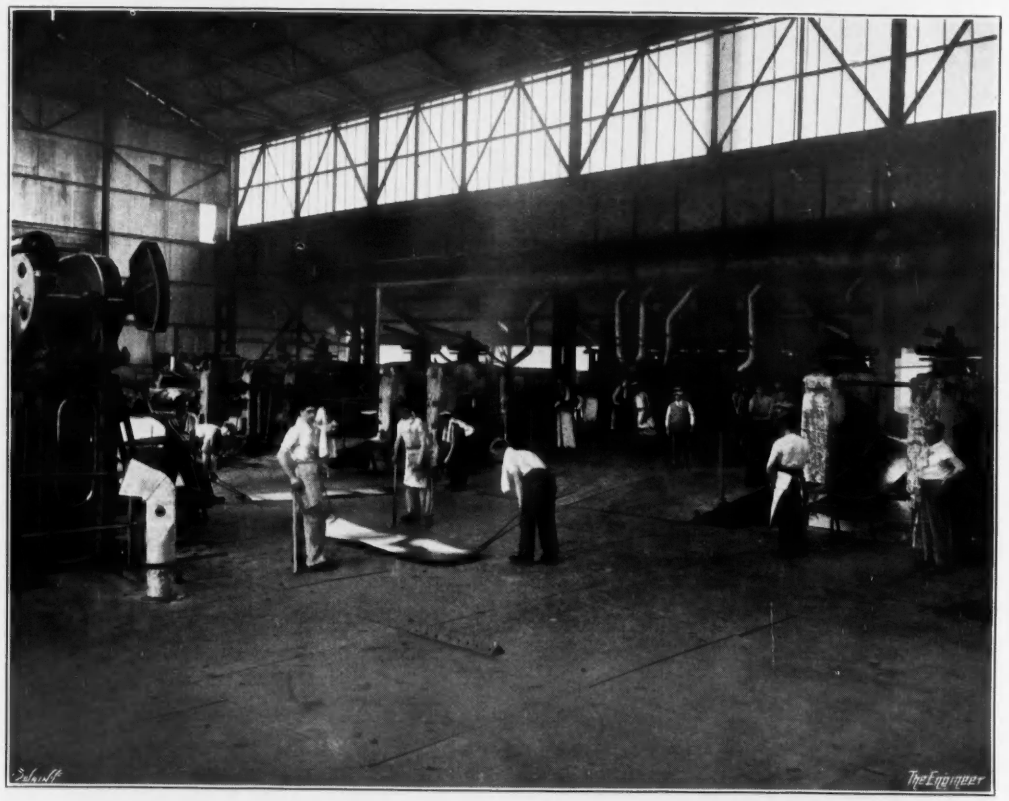


SOUTH AFRICAN IRON, STEEL AND INDUSTRIAL CORPORATION—PRETORIA WORKS









GENERAL VIEW FROM COAL TOWER—DECEMBER, 1933

CLOSE ANNEALING FURNACES—SHEET MILLS

PICKLING PLANT—SHEET MILLS

ROLLING FIRST CAST OF INGOTS—APRIL, 1934

GALVANISING MACHINES—SHEET MILLS

ROLLING MILLS—SHEET MILLS

UNIV. OF WICH.

The Engineer

JANUARY 24, 1936.

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Contents.

THE ENGINEER, January 24th, 1936. PAGE

A SEVEN-DAY JOURNAL ... 91
AMERICAN BEACH AND SHORE PROTECTION WORKS. No. II. (Illus.) ... 92
THE PRETORIA IRON AND STEEL WORKS. (Illus.) ... 94
105,000-KW TURBO-GENERATOR SET FOR BATTERSEA. No. I. (Illus.) ... 97
THE RIVER SEVERN BRIDGE. (Illus.) ... 100
RAIL AND ROAD ... 101
AIR AND WATER ... 101
MISCELLANEA ... 101
LEADING ARTICLES—
King George V ... 103
Papers and Proceedings ... 103
Kipling, The Engineer's Poet ... 104
LITERATURE ... 104
SHORT NOTICES ... 104
BOOKS RECEIVED ... 104
THE PHYSICAL SOCIETY'S EXHIBITION. No. III. (Illus.) ... 105
THE WATT LECTURE—THE TRANSFORMATION OF ENERGY ... 108
A SMALL CUTTER GRINDER. (Illus.) ... 109
ELECTRIC MOTOR GEAR UNITS. (Illus.) ... 110
THE QUARTER'S SHIPBUILDING RETURNS ... 110
UNEMPLOYMENT AND FOREIGN TRADE ... 110
SIXTY YEARS AGO ... 110
MARKETS, NOTES AND NEWS ... 111
CURRENT PRICES FOR METALS AND FUELS ... 112
FRENCH ENGINEERING NOTES ... 113
BRITISH PATENT SPECIFICATIONS. (Illus.) ... 113
FORTHCOMING ENGAGEMENTS ... 114
PERSONAL AND BUSINESS ANNOUNCEMENTS ... 114
CATALOGUES ... 114

TWO-PAGE SUPPLEMENT—SOUTH AFRICAN IRON AND STEEL CORPORATION—PRETORIA WORKS. INDEX TO VOLUME CLX.

KING GEORGE V.

ON May 10th, 1910, King Edward VII died, and George V ascended the throne. King Edward left a world at peace. The war in South Africa had come to its tedious end a few years before, a courageous treaty had been made with the Boers, and in this country the unhappy conflict had been well-nigh forgotten. The Kingdom of the new monarch had once more settled down to the prosecution of the peaceful arts and looked forward to another long era of tranquillity such as it had enjoyed under Queen Victoria.

But King George had worn the crown no more than three years when these hopes were shattered. On August 4th, 1914, Germany invaded Belgium, and on the same day Great Britain, conforming to its bond, declared war on Germany. That action and its sequels coloured the whole of King George's reign. For four years his realm and empire thought of nothing but war. All peaceful pursuits were brought to an end or subordinated to the needs of the armies in the fields and the fleets upon the sea. The country was more industrious than it ever had been, but it was the industry of waste and destruction . . . . The war ended and peace was restored by the Armistice of November 11th, 1918, and the Versailles Treaty. But it was a restless peace. Russia was passing through the worst throes of a revolution, which had utterly destroyed its ancient regime; Germany had cast out the military class, had debased her Emperor, and had become a republic; Italy turned from its old paths and, by a coup, Mussolini placed himself virtually in absolute power; Austria groaned under the deprivation of territory. The whole balance of Europe was upset. At home the people, particularly those who returned from the front, were led by a thoughtless catch-word to expect to find a "world fit for heroes to live in." They found that such a millennium was impossible. Economists had prophesied that an era of great prosperity would result from the necessity to make good the wastage of war. But it was soon seen that the beating of swords into ploughshares is no easy task for an exhausted world. The industrial revival was delayed, distress and high taxation pressed upon the King's people, men who had served in the armies found their occupations at home gone, and the great armament firms and others which had turned at the call of the country to the manufacture of munitions were unable to fill their works with orders . . . . A restless and unhappy period ended at last. A world boom came and for a few years there was unexampled prosperity. But it did not endure. In 1926 Labour made a terrible mistake. In May of that year it called a general strike which crippled industry and lost us for ever much of our foreign trade. It was followed a few years later by an industrial depression which affected the whole world, and of which King George V lived only long enough to know that its end was in sight.

We have summarised this tragic history of a reign because without it as a background it is impossible to appreciate the splendid duty which King George performed in circumstances which must have been bitter to his kindly nature. Devoted to the country and country pursuits, to his hearth, to his people and their industries, to all the things which might once have been expressed as English Life, an unwarlike King, yet plunged into war almost as soon as he reached the Throne; a lover of the people and diligent in all that affected their welfare, yet compelled to witness their distress. Anxious to live at amity with his neighbours, yet continuously menaced by the consequences of their internal dissensions and internal activities; dying with an economic recovery and the contentment of his realm in sight, but with the shadow of another war hanging over all.

Surely we may measure the greatness of men's souls by the response they make when an emergency drags them from the things they love, and their duty calls upon them to do the things they abhor. Judged by this standard, King George V will not be found wanting amongst Kings, but will be accorded by historians a place of great honour. Through all the troublous years of his reign the calming influence of the Throne was felt, not alone in the personality of the King himself, but in the members of his family. It is a tradition of the British Crown since the early years of Queen Victoria that it takes a personal and immediate interest in the activities of its people at home and overseas. Never was that tradition more admirably upheld than under the reign of King George and Queen Mary. Of the work of Her Majesty it is unnecessary to speak; there is almost a daily record of her intimate good actions amongst the people; nor need we speak of the position which the new King, Edward VIII, has already made for himself by his unceasing study of the industrial and economic life of the country and the Empire; nor need we speak of the duties performed by the other Princes and their Consorts. In all these activities we may see the hand and will of the late King. Without his guidance these things might not have been done. Even in these days a monarch continues to make his Court; it is as he desires, and leads, it to be. Under King George V the ruling motive was the welfare of the people. In many things he could only be guided by the actions of his Ministers, but outside and beyond whatever they might in their united wisdom decide, he could in his own person, and by deputy through his family, show his sympathy with the men, women, and children who were his subjects. For that he was held in love by his people, and by that he preserved his throne from attacks when others were being overthrown. For all this he will be remembered as the King of his People. And so, to adapt Henley's beautiful poem, he has passed to his rest,

"His task accomplished and the long day done,
"His wages taken, and in his heart
"Some late lark singing."

We wish, speaking as we feel sure we may for all members of the great industry and profession which we represent, to express to Her Majesty, to King Edward VIII, and to all the members of the Royal Family deep sympathy with them in their loss and to assure them that amongst all the people of the Realm and Empire King George V was respected, loved, and admired by none more than by engineers.

PAPERS AND PROCEEDINGS.

IN the January number of the *Journal* of the Institution of Mechanical Engineers there is printed the following appeal: "The Council take this opportunity to urge members who are engaged in practical mechanical engineering to submit papers on technical subjects. They recognise that the design and operations of machinery of all kinds, the lay-out of workshops, workshop methods and appliances, and all such practical subjects as come within the daily experience of mechanical engineers, are of equal interest with scientific subjects." The appeal is not made for the first time this year, nor is it stressed for the first time by the employment of italics. Nor is it, like the "Alms, alms, for the love of Allah" of the Eastern beggar after riches had fallen upon him, a mere repetition of a stereotyped phrase. We are convinced that it shows the very laudable anxiety of the Council to obtain a larger proportion of papers on real mechanical engineering. The cause of that anxiety is patent to all who attend the meetings of the Institution or who read its "Transactions." It is not easy to find a word which accurately defines the class of papers which now predominate. If we call them "scientific," we shall do an injury by apparent contrast with papers of a more practical, but not less scientific, nature; and if we call them "academic" we shall do an injury to them by seeming to suggest that they lack practical application. We require some term which whilst admitting the fundamental value of such papers to mechanical engineers, yet indicates that they are a little distant from the subjects which face the majority of mechanical engineers in their daily work.

It is fortunate that this lack of a clear definition should be of little moment. Every member of the Institution knows what we mean. Some, it is true, may draw fine arguments to demonstrate that the strength of materials, the nature of stresses, or the principles of combustion in internal combustion engines are essential mechanical engineering matters, but the majority will recognise that there are scores of subjects of a more practical nature which call for equal thought. Consider, for example, the small attention which has been given by the Institution to recent power station design and operation, or the little interest which it has shown in modern workshop methods of production, or its neglect in recent years of the descriptions of mechanical motions, the slight interest which it has exhibited in recent improvements in reciprocating steam engines, and the cold shoulder which it has turned upon advances in the mechanical design of turbines. Its members have, with regret, to seek in the "Proceedings" of less eminent Institutions and societies papers on such essentially mechanical engineering subjects as those mentioned and upon many others which might have been listed. No one will deny for a single instant that the fundamental principles upon which mechanical engineering is founded are of unsurpassed importance, but at the same time it must not be forgotten that the majority of engineers are more directly concerned with the use and conversion of materials, and with the practical utilisation of principles than with the fundamentals and principles themselves. The gardener who devoted excessive attention to the chemistry of soils and neglected the improvement of the strain of the plants which he grew would win no prizes. In the same way it is what the mechanical engineer produces that counts in the end. If only Mr. John Johnson's Thomas Lowe Gray lecture had been a paper what a discussion would have followed it! We shall not be misunderstood if we repeat that whilst fully recognising the value of the very "scientific" papers which characterise the meetings of the Institution, we heartily lend our support to the Council in its appeal for papers on "all such practical subjects as come within the daily experience of mechanical engineers."

We are not unaware that the Council is only in part responsible for the kind of papers which it accepts for reading and discussion. It has, in a great measure, to rely upon the papers that are submitted, and it is manifest from the appeal being necessary that too small a proportion of the contributions sent in are of a "technological" nature. The fact is that everyone who has conducted a research seeks publicity, and turns for it, quite naturally, to the leading Institutions. All the Institutions receive more than enough of such "papers," and since many of them are of considerable merit, it takes much strength of mind to refuse them. Probably the practical men are not infre-

quently over-ruled on councils and committees by the academic element. The papers are accepted out of deference to Science, and the Institution gradually acquires a reputation for being but little interested in technological subjects and problems. The Institution of Mechanical Engineers has an easy way out of the difficulty. It can print with written discussion the highly scientific papers and obtain for its meetings a larger number of technological papers. No one would be the loser, and many would gain, for we think it must be admitted that the verbal discussion of scientific and mathematical papers is rarely very illuminating, whilst those on technological subjects frequently bring out the useful exchange of practical experiences. There is, we know, a certain type of author who feels himself slighted if his paper is accepted for printing only and not for presentation. In his chagrin at the Council decision he threatens to withdraw it, thus placing the Council in a quandary from which the means of escape is not always clear. We do not venture to suggest to any Council—those of all Institutions are in the same boat—what course they should take in such circumstances, but we do suggest that they can reduce the frequency of such occurrences by firmly establishing a reputation for the kind of paper they feel to be most welcomed by and most valuable to their members, and most suitable for verbal discussion.

KIPLING, THE ENGINEERS' POET.

ENGINEERS are not less susceptible to the charms of poetry than other men. Many of them see, too, in their own works beauties which are hidden from the poets. The grace and rhythm of well ordered mechanical motion, the sweep of the structural curves in a well designed machine, mean something more to them than mere drawing-board perfection. They speak of fitness and harmony. They speak to engineers in a tongue which only one poet, Kipling, could hear. Nothing he liked better than talking of the works of engineers, and no man has succeeded in expressing emotions about the achievements of engineers more truly than did he. To him was given also the power to see the humours of engineering, as in "Steam Tactics," with Pyecroft and Hincheliffe, the immortals; the romance of it as in the "Ship that Found Herself" and "'Twixt the Devil and the Deep Sea"; and the deeper meaning which lies behind engineering as in several poems and in many lesser passages. The marine engine specially called to him, and in McAndrew's Hymn he interpreted its voice in words which many a hard-boiled Scots engineer knows by heart:

> "They're all awa! True beat, full power, the clanging chorus goes
> Clear to the tunnel where they sit, my purrin' dynamoes.
> Interdependence absolute, foreseen, ordained, decreed,
> To work, ye'll note, at any tilt an' every rate o' speed.
> Fra' skylight-lift to furnace bars, backed, bolted, braced and stayed,
> An' singin' like the Mornin' Star for joy that they are made;
> While, out o' touch o' vanity, the sweatin' thrust block says:
> 'Not unto us the praise, or man—not unto us the praise.'"

But he felt and wrote of the responsibilities that the civil engineer and the bridge builder bear with no less sympathy, as in "The Song of Martha":

> "They do not preach that their God will rouse them a little before the nuts work loose,
> They do not teach that His Pity allows them to leave their work when they damn-well choose;
> As in the thronged and the lighted ways, so in the dark and the desert they stand,
> Wary and watchful all their days that their brethren's days may be long in the land."

Or even more perhaps in "The Hymn of Breaking Strain," the last but one of his printed poems, which was first published in our pages on March 15th, 1935:

> "The careful text-books measure
> (Let all who build beware!)
> The load, the shock, the pressure
> Material can bear.
> So, when the buckled girder
> Lets down the grinding span,
> The blame of loss, or murder,
> Is laid upon the man.
> *Not on the stuff—the Man.*"

It is certainly of interest, and possibly not without significance, that Mr. Kipling chose an engineering newspaper for the first appearance of this poem. We may, indeed, claim him as the Poet of Engineers, and in no vocation is there deeper sorrow over his death.

Literature.

Physical Principles and Applications of Magnetochemistry. By S. S. BHATNAGAR and K. N. MATHUR. London: Macmillan and Co., Ltd. Price 21s. net. 1935.

THE book under review is intended mainly for chemists and physicists, although the authors hope that it will be found of interest to other workers who are engaged in the allied professions of metallurgy and engineering. Since it is concerned chiefly with the investigation and discussion of the properties of weakly magnetic substances, it is not likely to be of direct appeal to engineers, who may, however, turn to it for the definition of effects or phenomena with which they are not familiar.

As a guide to what engineers will find in this volume, perhaps it may be mentioned that the subject of ferro-magnetism, including ferro-magnetic alloys and their applications, is virtually confined to a chapter of some 20 pages, many of which are naturally devoted to theoretical treatment. Perhaps, too, it may be pointed out that the discussion of experimental methods and technique, while moderately wide, does not contain those details concerning experimental difficulties and sources of error which would obviously appeal to practical men.

The metallurgist may find rather more of interest to him than the engineer, although the former will undoubtedly like more practical details and will not be satisfied with a wealth of information on inorganic salts and organic substances. He will want to know more about alloys, yet he will look in vain for the name of Sadron in the index.

On the whole, the treatment of the magnetic problems of the metallic state is rather disappointing; only a few workers seem to realise their importance. The authors state that it is surprising that no systematic attempt has been made to study mercury and its amalgams, and that such experiments are now in progress in their laboratories. It is also surprising that they are content to record that the mass susceptibility of pure mercury is $-0{\cdot}19\times10^{-6}$ units per gm. Apart from such defects as those indicated, the work, as a book of reference on chemical and physical data, is an important addition to the literature of the subject.

SHORT NOTICES.

Steel of Empire. By John Murray Gibbon. London: Rich and Cowan, Ltd. 1935. Price 21s.—It would be difficult to conceive for a book a title more baffling to an indexer. This volume has nothing whatever to do with steel—unless it be steel rails—and one must assume that the author meant the word to be read in a poetical sense as implying the strength of the bonds of Empire forged by a great railway. The sub-title gives a better clue to the contents. It runs: "The Romantic History of the Canadian Pacific, the North-West Passage of To-day"; but even it gives an incomplete idea of the work, for the author devotes more than a third of his volume to an historical survey of the lure of Cathay and the Canadian West. The pages are peppered with little line reproductions—some very bad—of portraits and views, and are interleaved with half-tone and three-colour plates. But, despite these attractions, it is a difficult book to get on with. Principally, perhaps, because it is stuffed too tight with facts, quotations from authors, and a variety of snippets from the Press. The reader is rather confused by this mass of detail and before he has turned over many of the four hundred or more pages finds himself wishing for a less "varnished tale." But withal, we must praise Mr. Gibbon for the enormous amount of work he has put into the compilation and the assiduity with which he has collected quotations and cuttings. One feels that whenever a few facts about the growth of Canada may be needed they will be found within these covers. It is a well of information of which our chief criticism is that it is too deep.

Technical College Buildings: Their Planning and Equipment. London: Association of Principals of Technical Institutions, Chelsea Polytechnic, Manresa-road, S.W.3. price 3s. net.—This is a report by a joint committee of the Association of Technical Institutions, the Association of principals of Technical Institutions, with representatives of the Royal Institute of British Architects, the Institute of Builders, and a member of the Board of Education. It has been published, not with a view to introducing a stereotyped class of college building, but as a guide showing the best features in modern practice as applicable to such buildings. The book covers the important general features of buildings, general accommodation, and departmental accommodation, and gives plans and general descriptions of a number of technical colleges in Great Britain and abroad. It is well illustrated with plans and half-tones. The report will prove of use to local education authorities who are interested in the erection of new buildings for technical education.

Hutchinson's Technical and Scientific Encyclopædia. Volumes 2, 3, and 4. Edited by C. F. Tweney and I. P. Shershov. London: Hutchinson and Co. (Publishers), Ltd. Price £5 net the complete set of four volumes.—We said in the review of the first of these four volumes that we looked forward to receiving the remainder. It would not have been surprising if the high standard set by the first part of such a large work had fallen off in the succeeding volumes, but it has, in fact, been well maintained. As is only natural, four volumes covering such a large field cannot go into fullest detail upon all subjects, but where full information is lacking the books give valuable clues as to the type of textbook likely to be helpful. The four volumes cover the fields of physics, astrophysics, meteorology, horology, electricity, chemistry, geology, mineralogy, navigation, aeronautics, oceanography, geophysics, &c., whilst terms, processes, and data are given of the various manufacturing industries and skilled trades. When one consults this encyclopædia, either with the definite object of finding information or for general interest, their value is apparent, and although their price is high, they are well worth possessing.

Press Work Pressures. By C. W. Lucas. London: McGraw Hill Publishing Company, Ltd. Price 24s. net. 1935.—This book is intended as a guide for estimating the size of press required for given work and is, we believe, the first attempt to collect such information in one volume. The data it contains are based upon the author's twenty years' experience in press work and include the results of over 1000 tests. The information is given in the form of illustrated charts of the various types of jobs met with in press work, and opposite each chart are explanatory notes. Originally published as plates in the *American Machinist*, the plates have now been reproduced and with a certain amount of additional information classified into chapters on coining, drawing, embossing, forging, forming, hook seaming and curling, punching, shearing and cutting, riveting and miscellaneous operations. The book has obviously been compiled by a practical man and will be of value to those concerned in the operation and laying out of presses for all classes of work.

Weaving. By W. P. Crankshaw. Second edition. London: Sir Isaac Pitman and Sons, Ltd. 3s.—The first edition of this book was published in 1924 and it was reprinted in 1925. Mr. Crankshaw's knowledge of textile machinery and processes is a very wide one. He is a City and Guilds of London Institute Medallist in cotton, woollen, linen, and silk weaving, and was formerly examiner in the weaving branch of cotton manufacture for the Union of Lancashire and Cheshire Institutes. His object is to offer a brief account of the weaving processes while avoiding intricate details. Short chapters are included on the historical side of the subject, while the characteristics and production of the various yarns which form the raw materials of the weaver are dealt with. Considering the comparatively small size of the volume, the publishers are to be complimented on the clearness and care with which the illustrations have been produced.

Gas Meters. Third edition. By A. T. Gilbert. London: The Technical Press, Ltd., 5, Ave Maria-lane, E.C.4. Price 8s. 6d. net.—The third edition of this handbook has been considerably revised and much additional information is included. The introduction now contains a brief historical survey of gas meters and includes interesting details and diagrams of a number of the earlier types. Its contents, which are plentifully illustrated, cover in a clear and concise manner the various types of meters, their construction, operation, fixing, repair, and maintenance. This volume, like the earlier editions, will find a useful place among the reference works of those connected with the distribution side of the gas industry.

BOOKS RECEIVED.

Peace and the Colonial Problem. London: The National Peace Council, 39, Victoria-street, S.W.1. Price 6d. net.

Unsolved Problems of Science. By A. W. Haslett. London: G. Bell and Sons, York House, Portugal-street, W.C.2. Price 7s. 6d. net.

Limestones of Canada: Their Occurrence and Characteristics. Part 3. Quebec, Ottawa: The Department of Mines. Price 50 cents net.

Specification for Cast or Reconstructed Stone. London: Cast Concrete Products Association, Ltd., 20, Dartmouth-street, S.W.1. Price 2s. net.

Key in Our Bosom: The Monetary Problem Solved. By Whyte Hall. London: Heath Cranton, Ltd., 6, Fleet-lane, E.C.4. Price 3s. 6d. net.

James Watt: Craftsman and Engineer. By H. W. Dickinson. London: Cambridge University Press, Fetter-lane, E.C.4. Price 10s. 6d. net.

75 *Jahre Verein deutscher Eisenhüttenleute*, 1860-1935. Düsseldorf: Verlag Stahleisen m.b.H., Ludwig Knickmannstr. 27, Germany. Price R.M.5.

Small Alternating Current Motors. By A. H. Avery, A.M.I.E.E. London: Percival Marshall and Co., Ltd., 13, Fisher-street, W.C.1. Price 1s. 6d. net.

Boiler Feed Water Treatment. By F. J. Matthews. London: Hutchinson's Scientific and Technical Publications, Paternoster-row, E.C.4. Price 12s. 6d. net.

Electric Arc Welding Practice. By H. I. Lewenz, M.I. Mech. E., M.I.E.E. London: Crosby Lockwood and Son, Ltd., Stationers' Hall-court, E.C.4. Price 8s. 6d. net.

Management of an Enterprise. By C. Canby Balderston, V. S. Karabasz, and R. P. Brecht. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, W.C.2. Price 21s. net.

Hints on the Construction of a Railway in the Plains (with Special Reference to Bengal). By K. B. Ray. Delhi: The Railway Board, Manager of Publications. Price 1s. 6d. net.

Organisation and Administration of Industry. By F. T. Lloyd-Dodd, M.A., and B. J. Lynch. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, W.C.2. Price 15s. net.

The Physical Society's Exhibition.

No. III.

(*Concluded from page 71, January 17th.*)

APART from the speaking clock described in the previous article, G.P.O. research work was exemplified by the loud-speaking telephone, shown in Fig. 24. Composed of a table unit containing a microphone, loud speaker and "mains-driven" amplifier unit, the instrument is intended to form an adjunct to the subscriber's normal telephone, and it enables him to carry on a conversation with a distant subscriber just as if they were talking together in the same room. Any commercial telephone circuit is suitable for connecting the two subscribers' instruments together. But the use of a microphone and loud speaker combination in place of the usual arrangement introduces one great fundamental difference. With the ordinary telephone instrument it is usual to connect both the receiver and transmitter to the line simultaneously while the instrument is in use. The microphone and loud speaker of the equipment under consideration, however, cannot be simultaneously connected to the line, for when the microphone and loud speaker are situated in the same small unit the former will receive very loud signals from the loud

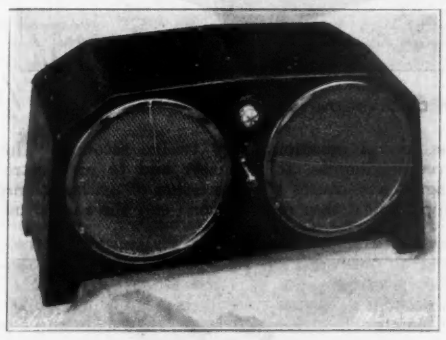


FIG. 24—LOUD-SPEAKING TELEPHONE

speaker—far louder, in fact, than those received from the subscriber when he speaks. If these loud signals are transmitted to the line to which the microphone and loud speaker are simultaneously connected they will be reproduced at great volume by the loud speaker. A vicious circle is formed. The whole arrangement is rendered unstable and is liable to howl violently.

But with this new type of loud-speaking telephone this difficulty is overcome by the use of a switching arrangement, operated by the subscribers' voices. When the user speaks into the microphone it is automatically connected to the line, while the loud speaker is disconnected. After he has finished speaking and when the subscriber at the other end replies, the speech currents received from the line automatically bring the loud speaker into use and disable the microphone side. An additional device enables one subscriber to "break in" on the speech of the other by interrupting in a loud tone of voice, just as when using the normal telephone. This break in facility enables the voice of the distant subscriber to take control of the switch against false operations by random noises in the room surrounding the microphone. Both the voice-operated switches and break-in switches operate with great rapidity. The beginning of the first syllable of a word causes switching and the word concerned is reproduced at the distant subscriber's instrument completely and in its original form. Current from the mains is only required whilst a call is in progress.

The amplifier box can be placed in any convenient position and be permanently wired to the supply mains and to a jack usually adjacent to the block terminals, used for the subscriber's ordinary telephone. To secure the best results the room in which the instrument is placed should be reasonably quiet and non-reverberant. An automatic volume control device for the incoming speech is also required, for otherwise if weak incoming speech is to be reproduced from the loud speaker with adequate volume, strong incoming speech will be unduly loud and will overload the amplifier. But with automatic volume control the incoming speech is always at a uniform and comfortable level.

The voice-operated switch A—Fig. 25—consists of a rectifier attenuation network inserted in the speech path and incorporating series and shunt rectifier elements. When the steady current flows in the direction of the arrow head the arrangement has a high loss, while if the control current reverses the loss becomes very small, as shown by the curve B. Four of these voice-operated switches are required, one in each of the main speech paths in the transmit and receive amplifiers, and one in each of the paths that carry the desired signals to provide the control currents to operate the switches, as indicated at C—Fig. 25. A differential bridge E provides the control current. Speech signals are rectified and by charging a condenser in the grid circuit change the grid bias potential of one of the valves in the bridge to unbalance it. The unbalance current flows through the switches and opens or closes them, as required, and the valves also amplify the speech signals.

The schematic diagram is shown at C. Reply speech signals from, say, the microphone are required to break in whilst signals are passing from the line to the loud speaker. These signals discharge the condenser in the grid circuit mentioned and the control current and the operation of the switches are reversed. The anti-side tone break in circuit provides an adverse polarising voltage to the rectifier in the break-in path and so prevents the side tone signal from the loud speaker to the microphone breaking in and interrupting the speech from the line. This polarising voltage is proportional to the speech signals and falls in between words and syllables to zero, thus enabling the true break in signal to operate.

As regards the automatic volume control device, the output signal is rectified and the resultant voltage applied in series with the normal negative grid bias potential of a valve to reduce the negative grid potential, which has a normal value about four times that which is required to reduce the anode current to zero, and when the output signal exceeds a predetermined level anode current flows. Two rectifiers are connected across the input circuit of the amplifier and the valve anode current flows through them. The impedance of the rectifiers is reduced so that the imput circuit is shunted and the maximum output signal is limited to the value that produces anode current. The circuit arrangement is shown at D and the output characteristic at F. The device operates in a few milliseconds and restores to maximum amplification in about two seconds, so that speech is satisfactorily reproduced.

Two exhibits of Marconi's Wireless Telegraph Company are shown in Figs. 26 and 27. The former is a highly selective and easily manipulated direction finder, and the latter a portable wireless receiver for use on police and other motor cars and motor cycle combinations. Although the direction finder is specially designed for use at aerodromes, it is equally suitable for ordinary traffic reception and direction-finding for ship to shore services. It provides for the circle, figure of eight, and cardioid polar diagrams of reception of C W, I C W, or telephony signals. The receiver is designed for use in conjunction with the Marconi-Adcock spaced aerial system, or the Marconi-Bellini-Tosi loop aerial systems, the outstanding feature of the former being its ability to operate by night when other systems are rendered useless by the phenomenon of "night effect." The standard model is designed to cover a wave range of 800 m. to 2000 m. or 375 to 150 kcs., but other wave ranges having a maximum to minimum wave length ratio of $2\frac{1}{2}$ to 1, with a minimum of 500 m., can be arranged for. When the equipment is installed on a suitable site, and when receiving normally polarised waves, a daytime accuracy of ± 2 deg. is obtainable. Under normal atmospheric conditions and with the standard Marconi-Adcock, 100ft. mast aerial system, the air to ground D F range is approximately 400 kilomes. from a standard Marconi type aircraft transmitter.

One of the chief features of the receiver—Fig. 27—is that reception on headphones or a loud speaker is possible whilst the vehicle is travelling at full speed.

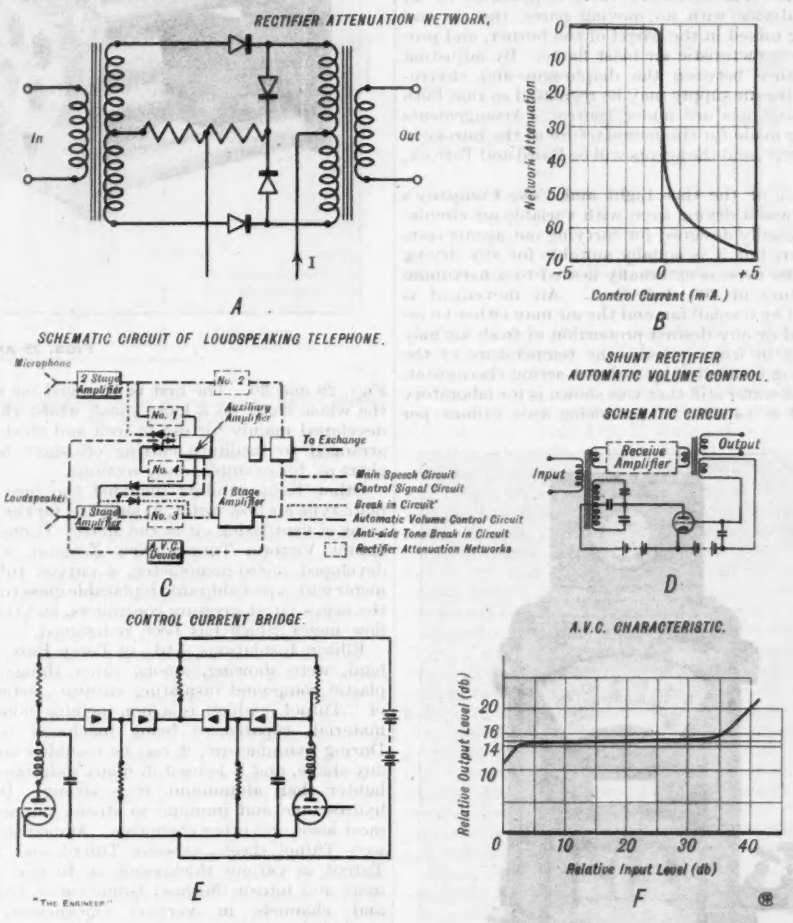
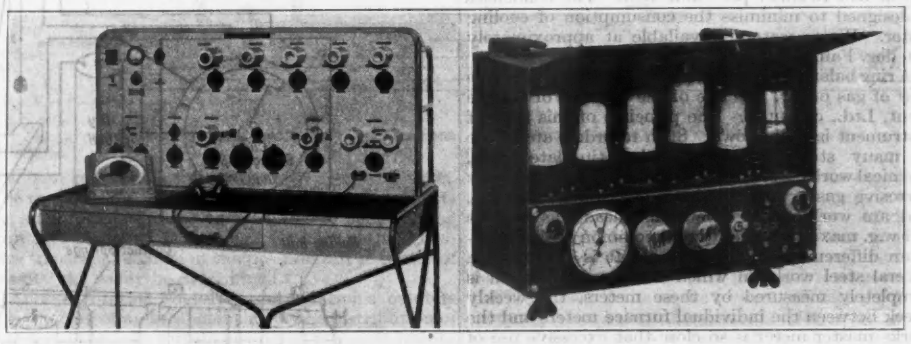


FIG. 25—LOUD-SPEAKER TELEPHONE CIRCUITS



FIGS. 26 AND 27—DIRECTION FINDER AND MOTOR-CAR RECEIVER

and CW, ICW or telephone signal reception is possible. The receiver is supplied to operate on a pre-selected wave length between the limits of 100 m. to 150 m., or 3800 to 1500 kcs., and provision is made for tuning it by approximately 3 per cent. on either side of the selected wave length. When used on motor cars and motor cycle combinations, the receiver derives its H.T. and L.T. supplies from a receiver supply unit fed from a 6 or 12-volt battery, which in the case of motor cars can be the starter battery.

The Gas Light and Coke Company, of Watson House, Nine Elms-lane, S.W.8, was exhibiting, among other things, the Berning burner, a new burner of German origin designed to generate its own air blast. It requires a normal low-pressure gas supply and a supply of A.C. at about 50 cycles, which operates an electromagnet controlling the movement of a rubber diaphragm in the base of the burner. Movement of this diaphragm produces a pulsating air movement. The necessary valve is provided by an injector device with no moving parts, the air and gas being mixed in the barrel of the burner, and produces a characteristic air blast flame. By adjusting the distance between the diaphragm and electromagnet, the air supply may be regulated so that both the air and gas are under control. Arrangements are being made for the manufacture of the burner in this country, and the agents will be Baird and Tatlock, Ltd.

Another of the Gas Light and Coke Company's exhibits was a drying oven with variable air circulation, originally designed for carrying out ageing tests on rubber, but it is equally suitable for any drying tests. The oven is externally heated to a maximum temperature of 200 deg. Cent. Air movement is produced by a small fan and the air may either be recirculated or any desired proportion of fresh air may be drawn in from outside, the temperature of the oven being controlled by a direct-acting thermostat.

A small water still that was shown is for laboratory use, and is capable of producing two gallons per

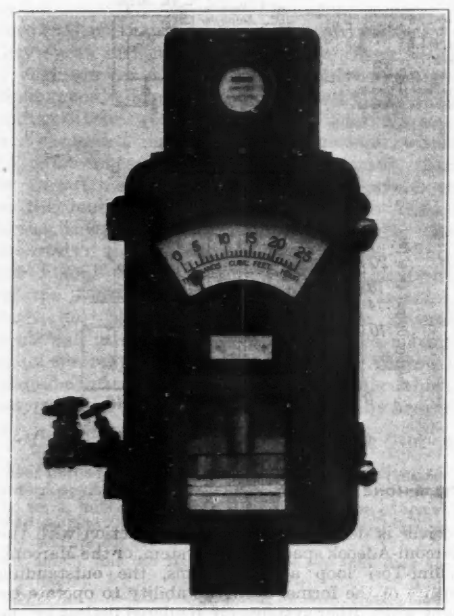


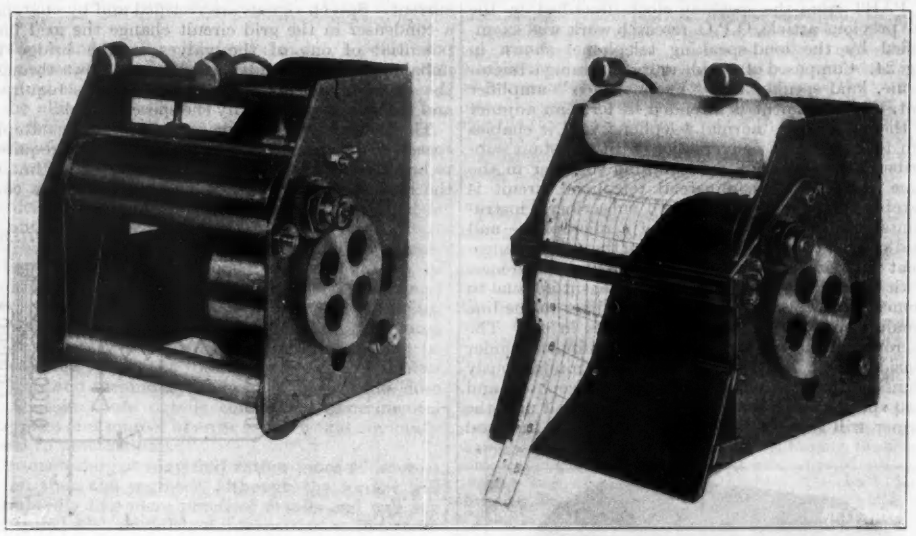
FIG. 28—RING BALANCE RECORDER

hour of high-quality distilled water. It was designed primarily with a view to obtaining high thermal efficiency, and this output is obtained with a consumption of something under 60 cubic feet, with gas of 500 B.Th.U. per cubic foot. The condenser is designed to minimise the consumption of cooling water. Waste water is available at approximately 180 deg. Fah.

A ring balance recorder—Fig. 28—for measuring the flow of gas or air, was one of the exhibits of George Kent, Ltd., of Luton. The principle of this type of instrument is well known. Such recorders are in use in many steel works, gasworks, tin-plate mills, chemical works, &c. They are used to measure highly corrosive gases, dirty producer gas, sewage gas, &c., and are working on differential heads as low as 0·1 w.g. maximum. They are in common use on maximum differentials of 0·3in. w.g. It is said that in several steel works in which the gas distribution is completely measured by these meters, the weekly check between the individual furnace meters and the works master meter is so close that excessive use of the ladle heating flare can be detected, notwithstanding that it only accounts for approximately ½ per cent. of the total flow. The recorder illustrated is housed in a standard jig drilled casing. An instrument supplied as a chart recorder only can readily be adopted on site for integration and/or flow scale indication.

When it is desired to transmit the record over a distance, the standard ring-balanced mechanism is fitted, with a transmitter operating on the Kent Telerecorder system. The receiving instrument may either be a recorder, indicator or integrator.

Several types of chart drives are available. The driving agent may be a spring clock or synchronous electric motor, and the same applies to the integrator drive. The chart speed may be 1in., 2in., or 3in. per hour. At 1in. per hour, which is the speed commonly used, the chart lasts thirty days. The two types of clock mechanism available are shown in



FIGS. 29 AND 30—CHART DRIVING UNITS

Figs. 29 and 30. The first is arranged for rewinding the whole chart on a loose spool, whilst the second, developed mainly for use in iron and steel works, is arranged to facilitate cutting off short lengths of chart as, for example, daily sections.

Other Kent exhibits included the firm's impact plate type air flow meter, as supplied for the measurement of ventilating air in the Mersey Tunnel and the Mount Victoria Tunnel, New Zealand, a recently developed micro-manometer, a curved tube manometer with a precalibrated replacable glass tube, one of the firm's latest pressure controllers, and the "KM" flow meter which has been redesigned.

Ellison Insulations, Ltd., of Perry Barr, Birmingham, were showing, among other things (such as plastic compound insulating varnish), articles made of "Tufnol," which is a non-metallic homogeneous material, capable of being machined with ease. During manufacture, it can be moulded into almost any shape, and it is used in many industries. While lighter than aluminium, it is strong. It is non-hydroscopic and immune to steam, oil, water, and most acids and other chemicals. Among the exhibits were Tufnol sheets, asbestos Tufnol, and lead-lined Tufnol in various thicknesses up to 6in., and with matt and mirror finishes: tufnol tubes, rods, angles, and channels in various thicknesses. Tufnol machined parts consisted of a thermometer holder, a flexible high-tension cable cover, temple rollers,

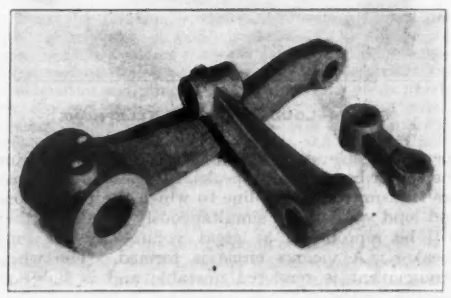


FIG. 31—"TUFNOL" LINKS

nuts, and bolts, stocking formers, a humane stunner, &c. Tufnol links used in a wrapping machine to reduce weight and increase speed are shown in Fig. 31.

A relay for operating two circuits alternately with delayed action was one of the exhibits of the National Physical Laboratory. A synchronous gramophone motor—Fig. 32—operated on the 50-cycle mains, drives a drum geared to rotate once every second. At each revolution a brass strip let into the drum closes a circuit between two springs and causes an impulse to be given to a synchronous clock, which, by means of the hand, makes an electric contact of one second duration every twelve seconds. This gives an impulse to a buzzer and to an electromagnet and causes the depression of a wire stirrup supporting a thin rod. At one end the rod is universally jointed so that when the stirrup is depressed the other end of the rod falls. But since it is guided by a system of wires, the path of the rod's extremity during a complete cycle is a quasi-figure of eight having two lower and two upper points of rest.

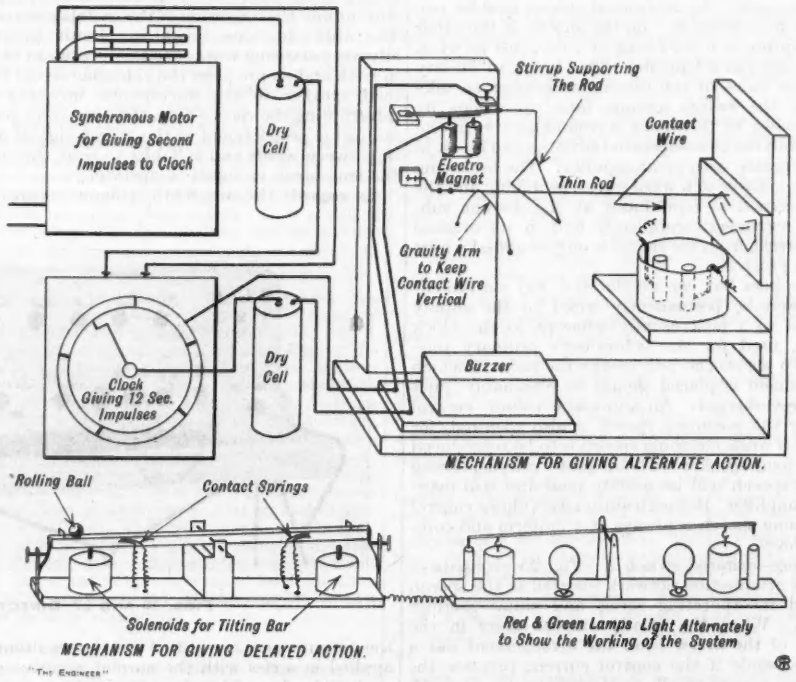

Synchronous Motor for Giving Second Impulses to Clock
Dry Cell
Stirrup Supporting The Rod
Contact Wire
Electro Magnet
Thin Rod
Gravity Arm to Keep Contact Wire Vertical
Clock Giving 12 Sec. Impulses
Dry Cell
Buzzer
MECHANISM FOR GIVING ALTERNATE ACTION.
Rolling Ball
Contact Springs
Solenoids for Tilting Bar
MECHANISM FOR GIVING DELAYED ACTION.
Red & Green Lamps Light Alternately to Show the Working of the System

FIG. 32—RELAY FOR OPERATING TWO CIRCUITS WITH DELAYED ACTION

Two mercury cups are placed so that when the rod is at either of the lower points of rest a short vertical wire attached to the rod dips into one or other of the cups. Having been released by the stirrup, the rod falls until it reaches a lower point of rest, where it

remains until the hand of the clock advances at the end of a second. The magnet then releases the stirrup, which springs back, carrying the rod up to an upper point of rest, where it remains until the clock sends another impulse. The mercury cups are connected in circuit with two solenoids, which are therefore operated alternately every twelve seconds and cause a bar pivoted about its centre to change the direction of its tilt. A 1in. steel ball runs down the bar between steel rails in a definite time and near the end of its journey presses into contact two steel springs to which platinum contacts are attached. By the closing of these contacts the final circuit is closed and the associated mechanism operated. This occurs at a definite interval after the warning signal has been given by the buzzer. When the reversal of tilt is given to the bar the latter is prevented from slipping back under the weight of the ball by the friction of two adjustable strip springs. For the purpose of demonstration the mechanism was arranged to light a red and green lamp alternately.

The diagram Fig. 33 relates to a bridge for the

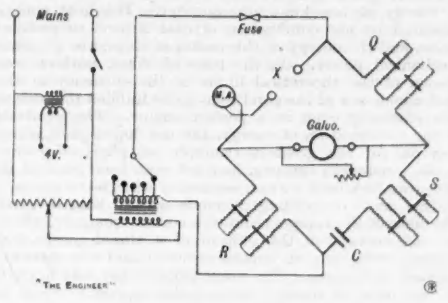


FIG. 33—INDUCTANCE BRIDGE

measurement of inductance under load at supply mains frequency. It was shown by the Baldwin Instrument Company, of "Brooklands," Dartford, Kent, and is claimed to be more simple to operate than other bridges designed for the same purpose. By "ganging" the resistance arms the instrument has been made to give direct readings of inductance and phase angle suitable for test room determination of the impedance of small coils, such as those of relays, under working conditions. Designed for a frequency of 50 cycles per second, the instrument has a range of 1 to 100 henries. It gives phase angles from 41 deg. to 90 deg. and carries up to 25 milliampères load on the coil under test. Within certain limits these ranges can be modified to meet requirements. The non-inductive resistance arms Q and R consist of specially shaped rheostats designed to give a logarithmic scale of inductance, and both are operated simultaneously by one draw rod. C, the capacitance, is in the form of a high-voltage standard mica condenser.

The value of the inductance is given by $L = \frac{Q\,R\,C}{1+\omega^2 C^2 S^2}$ when the bridge is balanced. The scale of the inductance (Q R) slider is calibrated in terms of the product Q R C. The other slider calibrated in phase angles actuates the resistance S. The scale of phase angles is approximately uniform over the range from 41 deg. to 90 deg. The term $1+\omega^2 C^2 S^2$, which modifies the actual value of inductance for a given value of Q R C, is a function of S alone, since ω and C are constant, and since the inductance scale is logarithmic, the necessary correction is simply applied by the automatic displacement of this scale by the displacement of the phase angle slider. Balance is obtained by moving two draw rods. When balance is secured the value of the phase angle is read directly under the hair line over one scale and the corrected value of the inductance is read off the other scale. There are thus only two movements needed to obtain a balance and readings are made directly without the need for calculations.

A convenient protractor is supplied, from which, given L and θ, R and Z can be read. A very sharp balance is obtained on a vibration galvanometer and the accuracy of both inductance and phase angle is within ± 2 per cent. The power supply is from the mains. Current regulation in the coil under test is obtained by a multi-ratio transformer, the primary of which is fed from a continuously variable tap on a resistance across the mains. A coarse adjustment is made by a tapping switch on the transformer secondary actuated by a knob on the front of the instrument case, while fine adjustment is made by another knob operating the variable resistance.

To safeguard both the instrument and the operator the "on-off" switch and the two means of current regulation are interlocked. The mains switch can be opened in any position of the controls, but once opened cannot be closed again unless the transformer tapping switch is returned to the minimum voltage position. This tapping switch can be returned to the minimum position in any position of the regulator, but cannot be moved to a higher voltage position unless the regulator is turned back to its minimum voltage position. A pilot light is provided to show when the switch is on. The current passing through the coil under test is measured by a thermo-couple milliammeter reading to 25 m.a. mounted in the panel. A shunt, also mounted on the panel, is fitted to control the sensitivity of the galvanometer. A transformer giving 4 volts is fitted to supply the signal lamp and a plug is provided to enable the galvanometer lamp to be fed from this circuit.

The Fuel Research Station, of River Way, Blackwall-lane, East Greenwich, was showing apparatus for detecting and investigating the settlement of suspensions. The apparatus—Fig. 34—has been

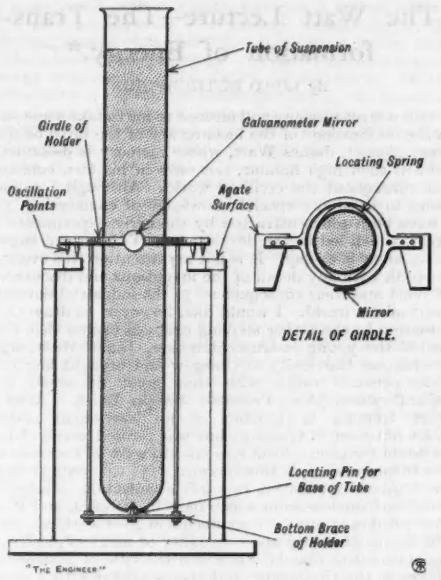


FIG. 34—APPARATUS FOR MEASURING SETTLEMENT IN SUSPENSIONS

devised for detecting slight settlement of the solid materials suspended in an opaque liquid and for estimating the amount of settlement without in any way disturbing the suspension. As settlement proceeds the centre of gravity of a column of the suspension falls and this can be detected by utilising the column as a part of a pendulum and measuring the period of swing. The suspension is contained in a glass boiling tube, 8in. long and 1in. in diameter. When filled with the suspension the tube is placed in a light metal holder and is capable of oscillating on points, the period of the pendulum being plotted against the age of the suspension. The arrangement will enable a movement of the centre of gravity of less than 0·1 mm. to be detected with ease as a change in period. A given change in the centre of gravity has a greater effect the nearer the centre of gravity is to the axis of oscillation, but this is partly offset by a greater deviation in duplicate observations of the period. In a suspension containing 40 parts of coal of specific gravity, 1·3 and 60 parts of oil of specific gravity, 0·9 complete separation in a depth of 15 cm. to 17 cm. could cause a maximum change of about 8 mm. in the centre of gravity. This gives a scale of at least 80 units within which to distinguish degrees of settlement and with which to characterise oils. Care must be taken in the preparation of a suspension to ensure that it is free from air bubbles. A mirror reflects a pencil of light on a suitable scale. The pendulum is set swinging or is stopped by directing small puffs of air on to it through a tube passing through the wall of its housing. By a simple modification the actual change in the position of the centre of gravity can easily be determined.

Another of the Fuel Research Station's exhibits was a model of an arrangement for the distribution of powdered fuel. In certain powdered fuel installations it is essential for the air-borne fuel to be divided into two or more exactly similar streams so that it may be distributed to a number of burners. Owing to the fact that fuel across the original stream is not uniform, either as regards the concentration or the size of the particles, it has proved very difficult to separate the streams into two or more equal parts. In the model that was exhibited, however, the whole cross section of the main stream is divided into a large number of small squares—Fig. 35—each of which is the entrance to a duct. By suitably inclining alternate rows of ducts the air and fuel are led into two branch pipes connected to powdered fuel burners in such a manner that no two adjacent squares in the main stream supply the same burner. The method is being successfully employed on a number of Lancashire boilers to supply two furnaces with equal quantities of air and fuel from a single unit pulveriser. Although originally devised for the purpose just mentioned, the device can be used in several other ways, *e.g.*, for sampling large or small solids and for mixing any form of fluid material. A full description of the scheme was given in our issue

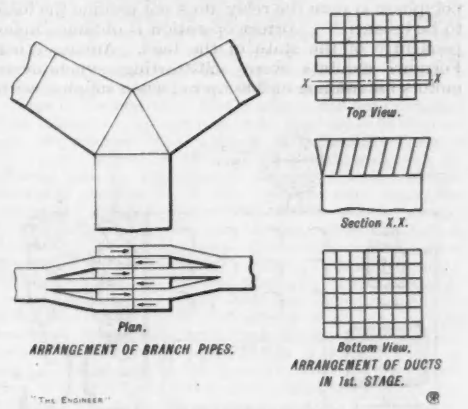


FIG. 35—TWO-WAY DISTRIBUTOR FOR PULVERISED FUEL

of October 4th, 1935 in connection with the Engineering and Machinery Exhibition at Olympia.

Apparatus for measuring the density of gases—Fig. 36—was also shown. It depends on the flotation of a balanced glass bulb in an atmosphere of gas. A sealed glass bulb A attached to a graduated arm B is balanced on a knife-edge D, the bulb A being enclosed in a second and fixed bulb E with an inlet for the gas under test. The opening at H is made as small as is compatible with the free movement of the suspended portion. Gas under pressure is introduced through a drying tube P and the cock G. When the latter is closed back diffusion of air through H is prevented by passing a small amount of gas through the by-pass J. A thermometer can be inserted at K, if desired. The apparatus was described fully in the *Journal of Scientific Instruments* for October, 1935. Briefly, it is operated by counterbalancing by riders such as L and M the change in upthrust on the sealed bulb A when surrounded successively by air and gas, the determination of the gas factor being carried out by means of the rider on the lower beam. In order that the volume of gas required may be small the annular space between the suspended sealed bulb and the fixed bulb is made as small as possible. This also provides heavy damping and enables a high degree of sensitivity to be combined with rapid manipulation.

A maximum demand warning system (Fig. 37) was among the exhibits of Nalder Brothers and Thompson, Ltd., of Dalston-lane Works, E.8. The equipment consists at the control end of contact making apparatus and visual signalling devices at the various load centres. Maximum demand is summated, measured, and recorded in kilowatts or kilovolt-ampères. Control is effected by maximum demand time lag relays and auxiliary contactors. The remote signalling units comprise in each case three coloured lights analogous to those used for automatic street traffic control. Under normal conditions all the green lights are switched on to indicate that the total load is within the prescribed limits of the lower tariff rate; the use of power then being unrestricted. But if the power demand increases to a value at which it would be unsafe to add more load, the green light is extinguished and an amber lamp lights in its place. If the power demand continues to increase still further, and is sustained over a predetermined time, the red light comes into action. Provision is made for varying the predetermined values of the demand rate at which the amber and red signal lights will glow. When required, the red signal is supplemented by an audible alarm signal, such as a gong or Klaxon horn.

A new maximum demand alarm relay, Fig. 38, was exhibited by Ferranti, Ltd., of Hollinwood, Lancs. It gives an advanced warning of the maxi-

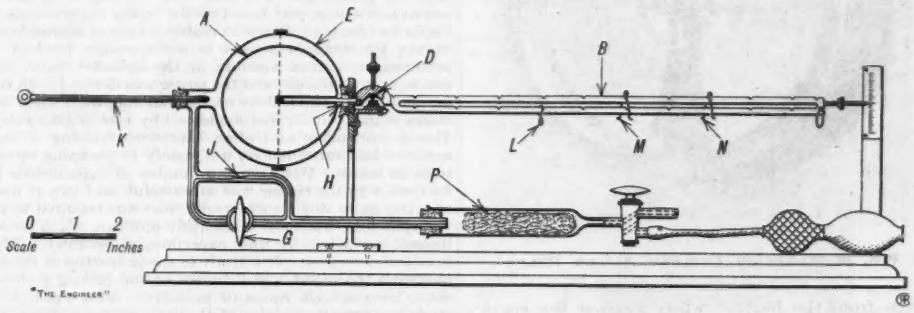


FIG. 36—BALANCE FOR MEASURING THE SPECIFIC GRAVITY OF GASES

mum demand being reached, and is operated by impulses from a pair of contacts on a watt-hour meter or a kVA-hour meter in a similar manner to an impulse type maximum demand indicator. Resetting is effected by a synchronous timing element incorporated in the relay and takes place every 10 min. Alarm contacts may be set at any predetermined value. If during the 10-min. period the load has been of such a value that if it were continued for the full demand period the stipulated maximum demand would be exceeded, an alarm is sounded on a separate bell connected to the relay contacts. In the case of a polyphase system the relay does not assume the load to be balanced. Correct operation is obtained independently of the state of the load. Among other Ferranti exhibits were self-starting synchronous motors for running at 200 r.p.m., when supplied with

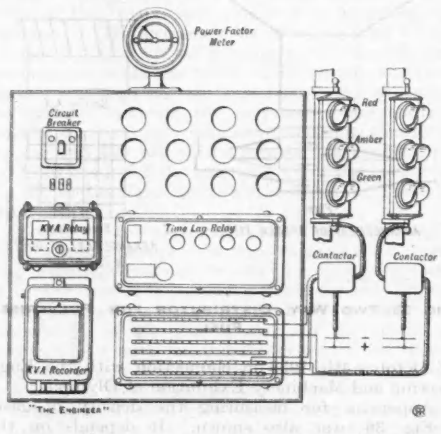


FIG. 37—MAXIMUM DEMAND WARNING SYSTEM

50-cycle current. While the synchronous torque is 20 gm./cm., the consumption is only 1·4 watts. Motors of this type serve as the driving element of a 6in. dial stop clock reading to within 0·05 sec. Motors with and without gearing were shown, also a motor lifting a heavy weight. There was a range of 2in. dial-moving coil instruments for measuring from 250 micro-ampères to 10 ampères, rectifier instruments, electrostatic voltmeters, &c.

Most of the exhibits of Crompton Parkinson, Ltd., of Bush House, W.C.2, corresponded with those previously shown, but there was a new Tong Test instrument specially designed for use in motor garages. With its components the instrument enables the battery voltage to be measured. It is also capable of measuring the current in the lighting circuit from 3 to 15 ampères, or from 6 to 60 ampères, and that

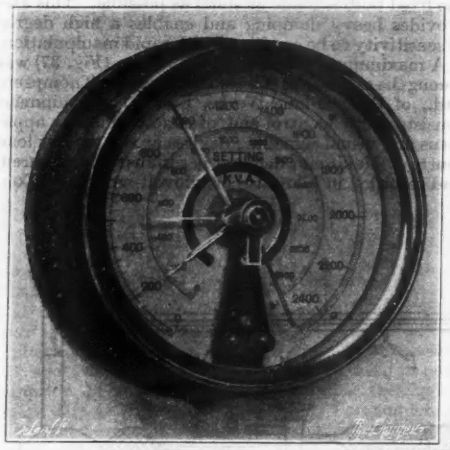


FIG. 38—MAXIMUM DEMAND ALARM RELAY

taken from the battery when starting the engine. Under the latter conditions readings from 60 to 400, or even 800, ampères can be obtained. The equipment consists of a Tong Test instrument with an additional movement unit and another unit to give the voltage and low current ranges.

A new watch rate recorder exhibited by the Western Electric Company, of Bush House, W.C.2, is used for the measurement of the instantaneous rate of five ticks per second watch mechanisms. The watch ticks are picked up from the watch by means of a vibration pick-up, and the corresponding electrical impulses are fed to the grid of a frequency primed thyratron. The grid frequency controls the thyratron and its output is used to operate an impulse stylus which records a mark on a revolving recording drum, driven by a synchronous motor from a standard source of time, so that it makes one revolution for each one-fifth second, or approximately one revolution for each tick impulse from the watch. The stylus is also driven along the axis of the drum, and for a watch in accurate adjustment it records a horizontal line of marks. If the watch is gaining or losing the stylus records a line of rising or falling slope, calibrated in terms of seconds per day. The maximum accuracy of reading is to one second per day, and the operation of measurement can be made in either five or thirty seconds, according to the accuracy required. The standard source of time driving the recording drum is a thermostatically controlled tuning fork.

The Watt Lecture—The Transformation of Energy.*

By LORD RUTHERFORD.

IT is a great pleasure and interest to me to take some part in the celebrations of the bicentenary of the birth of that great pioneer, James Watt, whose memory is deservedly held in such high honour, not only in his own country, but throughout the civilised world. Although I cannot claim to have any special knowledge of engineering, yet I have been much attracted by the early experiments of Watt, which led to the development of the steam engine as we know it to-day. It is not my intention this evening to speak with any detail of the inventions and discoveries of Watt and their consequences to the industrial development of the world. I would like, however, to draw your attention to the rather striking chain of events that connected the young instrument maker, James Watt, with the famous University of Glasgow and brought him into close personal touch with that great Scotsman and natural philosopher, Professor Joseph Black. After a short training in London as an instrument maker, Watt returned to Glasgow, but was refused permission—no doubt for good official reasons—to work at his trade by the Incorporation of Hammermen. At this critical stage the University received as a gift a collection of astronomical instruments from a merchant in Jamaica, and Watt was called in to put the instruments in good working order. His technical ability and originality of mind so impressed the authorities that he was given the title of Instrument Maker to the University, and also provided with a workshop in the buildings not far away from the rooms assigned to Professor Black. Eight years senior to Watt, Black was a man of great originality and power, who had already made outstanding discoveries in science and particularly in the subject of heat. He was a pioneer in the measurement of heat, and was the first to introduce the idea of "latent heat" in studying the conversion of ice into water, and also had made measurements on the latent heat of steam in 1761. Some years before Watt began his experiments on the steam engine.

Black and Watt soon became friends, and it was a happy chance of destiny that brought the future inventor of the steam engine in close personal relations with one of the greatest scientific men of his age and probably the greatest authority at that time on the subject of heat. There can be no doubt that the association of Watt with the University was the turning point of Watt's career, for not only did it give him a favourable opportunity to begin his experiments on the steam engine, but what is more important, provided him with an ideal environment for acquiring that breadth of scientific outlook and knowledge which so markedly distinguished him from the engineers of his time. Watt was not unmindful of the debt he owed to Black for his training in scientific method, for in later days he wrote: "To him I owe in great measure my being what I am; he taught me to reason and experiment in natural philosophy and was always a true friend and adviser." On the other side, Black admired Watt's mechanical knowledge and remarkable powers of invention. It is pleasant to recall the long standing friendship between these two great men, each in his own sphere of activity a true pioneer of scientific progress. This training in scientific method was invaluable to Watt when he began to experiment with the model of the Newcomen engine which belonged to the University. This type of steam engine, used for pumping water, had been developed by Newcomen and was in part based on the earlier experiments of Papin and Savery. It was in reality a type of atmospheric engine, for steam was used as a convenient method of producing a partial vacuum in the cylinder below the piston open to the air, and the power was derived from the pressure of the atmosphere on the moving piston when the steam in the cylinder was condensed by a jet of cold water. The uneconomical and often capricious running of this machine had restricted its use mainly to pumping operations in mines. Watt made a number of experiments to find out why the engine was so wasteful, and why it used so much more steam each stroke than was required to fill the cylinder. This was a scientific problem which he set himself to solve by the experimental method. This involved a very complete study of the properties of steam, including the direct measurement of the boiling point of water over a wide range of pressure. After exhaustive trials he correctly concluded that the source of the main trouble lay in the cooling of the cylinder walls by the jet of cold water necessary to condense the steam and produce a vacuum in the cylinder. When steam again entered the cooled cylinder a large part of it was condensed and wasted in heating up the walls of the cylinder to its own temperature. When once the source of trouble had been diagnosed the remedy used by Watt appeared to be very simple, for he arranged that the steam in the cylinder was connected at the appropriate moment with an external separate condenser kept at a low temperature. In this way a good vacuum was produced in the cylinder without cooling it; the waste of steam was much reduced, and the efficiency of the engine thereby markedly increased. This modification of the Newcomen engine is liable to give to-day a deceptive impression of simplicity and obviousness. It required, however, the genius of a Watt to recognise there was a problem waiting to be solved. The solution was not arrived at by haphazard experimentation, but was deduced after an admirable and difficult investigation of the processes occurring in the steam cylinder.

It is difficult to overestimate the fundamental importance of this invention of Watt, for within it lay the germ of the practical development of the steam engine. He soon followed this up by arranging to admit steam alternately to both sides of the piston, thus making the first true steam engine. It is known to all what great contributions in later days were made by Watt to his able associates, Roebuck and Boulton, in developing the steam engine as a reliable and efficient instrument for the generation of power, resulting in a rapid acceleration in the application of power for industrial purposes.

I have referred to this pioneer work of Watt as a striking illustration not only of his technical capacity, but of his ability as an original investigator, and his power of reaching a simple and definite solution of a complicated problem. While the primary object of Watt was to improve the steam engine for practical purposes, yet we know he was deeply interested in the underlying processes occurring in the steam cylinder during the operation of the engine, and later designed his well-known steam indicator in order to measure the pressure of the steam at each point of the stroke of the piston. This instrument has proved invaluable in the detailed study of the efficiency of engines and helped materially in the subsequent evolution of the steam engine.

I must now turn to the main subject of my lecture, the Transformation of Energy. The steam engine is an apparatus designed for the production of mechanical power from the combustion of coal, and is an excellent example, but a complicated one, of the transformation of energy of one kind into another. The heat energy liberated by the combustion of coal is used to produce steam and the energy of this steam is utilised to generate mechanical power. At the time of Watt, nothing was known of the theoretical limits of the efficiency of the heat engine nor of the conditions to be fulfilled to increase this efficiency even in a perfect engine. The principle of the conservation of energy, the development of which was one of the greatest triumphs of physical science in the nineteenth century, had not even been guessed at. When we look back we can see clearly why the recognition of this great over-riding principle was so long delayed. The idea of the conservation of a certain quantity, which we call energy, in the motion of a closed mechanical system, arose early in dynamical theory and was probably divined by Newton. The conversion, at any rate in part, of one form of energy into another appeared clear in certain simple cases. For example, a bent spring possesses energy, for it is capable of doing work when it is released. The potential energy of a weight raised above the earth is converted into energy of motion when it falls under gravity. It was clear, also, that an explosive mixture contained a store of energy which is released by its detonation, and is thus capable of doing work. When, however, we come to the more subtle forms of energy, conditions of the transformation of energy into mechanical power were far more nebulous. This was markedly the case of heat, for here the old doctrine of caloric, which held that heat was a material substance, incapable of being created or destroyed, blocked the way to further progress. It was true that the experiments of Count Rumford in 1798, in which he showed that large quantities of heat were produced as a result of friction in boring cannon, indicated that the original idea of caloric was untenable, and that heat must rather be a mode of motion of the particles of matter. The old doctrine was, however, too strongly established in the minds of men to be easily displaced. It was not until the arguments of Mayer in 1842 on the relation between heat and work and the accurate measurements of Joule, of Manchester, on the heat produced by friction that the new idea of a definite equivalence between heat and work was firmly established. Joule's accurate measurements of the mechanical equivalent of heat under difficult experimental conditions stand out as one of the greatest experimental achievements of physics in the last century. These results, together with Joule's investigations of the heating effect of the electric current, did much to establish the principle of the conservation of energy on a firm experimental basis. I must not omit to mention that Helmholtz, in 1847, unaware of the work of Mayer and Joule, in a famous paper put forward in a definite form the principle of the conservation of energy in all types of transformations, and traced its application over the whole range of physics.

Even when the universality of the principle of conservation of energy was recognised, and heat was inferred to be a mode of motion of the molecules of matter, there was needed much clear thinking before the principles underlying the conversion of heat energy into useful work was understood. The clearing up of this subject we owe mainly to the work of Kelvin and Clausius, who independently attacked the problem about the same time and reached similar conclusions. In a famous memoir published in 1826, Sadi Carnot had examined the efficiency of reversible heat engines on the basis of the idea of caloric. This question was taken up and developed by Kelvin on the newer ideas of heat and on the basis of the conservation of energy. Both Clausius and Kelvin enumerated the two famous laws which all thermodynamical systems must obey. I remember speaking with Kelvin in his later days about this work, and he told me that at the time he put forward these laws, he had no idea of the importance they would ultimately obtain, or of the wide development that would follow from them. Yet we know that based on these ideas there has arisen a new branch of knowledge—thermodynamics—which has proved of great importance to both physics and chemistry.

On these views only part of the heat energy in the working substance is available for useful work, the fraction depending on the absolute temperatures T_1 and T_2 of the boiler and condenser respectively. The efficiency of an ideal reversible engine working between 100 deg. and 0 deg. Cent., *i.e.*, 373 deg. and 273 deg. absolute, cannot be greater than 27 per cent. To improve the efficiency it is necessary to increase the difference between T_1 and T_2. The improvement in condensing practice soon reduced T_2 to the practical minimum, so that any further improvement depended on raising the temperature T_1, *i.e.*, by using higher steam pressure. Step by step, steam pressures have been steadily raised and high-pressure steam of 1400 lb. or more has been used with steam turbines. Obviously, the use of such high temperatures and pressures, where the boiler is almost red hot, have been beset with great technical difficulties, which have only been surmounted by constant experiment and improvements in method and materials.

In order to avoid the danger and difficulties of the use

* Greenock Philosophical Society, January 17th, 1936.

of such high-pressure steam, mercury has been used in the boiler instead of water. Its boiling point is 357 deg. Cent., in contrast with 100 deg. Cent. for water. This idea was taken up and developed with great ingenuity by W. L. R. Emmet, of the General Electric Company, U.S.A. The mercury is vaporised at a reasonable pressure in a special boiler, and the vapour then passes through a turbine. The heat liberated by the condensation of the mercury is used to produce steam of moderately high pressure, which, in turn, passes through a turbine. The overall efficiency of this confined system is found to be about 34 per cent. under normal working conditions. I understand that three large plants on this system are now in successful operation for the generation of electric power. Experiments of this kind on a practical scale are of great interest and importance in the continuous search for an efficient and advantageous machine for the production of power from heat. Obviously there are many factors, both technical and economic, to be taken into account in assessing whether the mercury engine is likely to be a formidable rival to the high-pressure steam turbine.

Even under the best conditions so far realised, it has not been found possible to obtain an efficiency of as much as 40 per cent. for any form of heat engine, so that more than 60 per cent. of the heat energy is wasted from the point of view of the generation of mechanical power.

It is natural to ask whether more of the chemical energy in the coal could not be utilised by employing other methods not involving the use of the heat engine, with its inevitable low efficiency. It has been suggested that in some way the energy of the carbon might be transformed directly into electrical energy in a special form of electric battery. Experiments in this direction have been made, but so far without much success.

It will be remembered in the early days of Science, much time and ingenuity were expended in devising machines to achieve perpetual motion. In the beginning, these machines depended on mechanical principles alone, but following the discovery of new types of forces, electric and electro-magnetic in origin, still more complicated machines were devised for the purpose. While no doubt this search for a perpetual motion machine is an example of the primitive desire of mankind to obtain something for nothing, yet it is surprising what ingenuity has been displayed in the design of such mechanisms which always failed to achieve their purpose. It may even be urged that the rise of the principle of conservation of energy, and certainly the enunciation of the laws of thermodynamics, were in no small part due to the failure of the experimenters to produce a successful perpetual motion machine. It must be borne in mind that "energy," which is generally defined as "the capacity for doing work," is an abstract conception, for energy can neither be seen nor measured directly. Its evaluation depends on the measurement of other quantities, and these are different for each type of energy involved. While it is an act of faith to believe that the conservation of energy does apply to all physical systems, yet we know it is difficult in many cases to obtain a direct experimental proof of its validity. Each case of transformation has to be examined with great care to be sure that energy has not disappeared in some unrecognised form. The need for such discrimination is clearly indicated by a comparison of the modes of transformation of electric energy in a conductor traversed respectively by direct current and by an alternating current of high frequency. In the case of the direct current, the electric energy is dissipated in the conductor and is transformed directly into heat. In the case of a high-frequency alternating current, such as passes through the conducting network of a radio transmitter, only part of the electric energy is dissipated in the form of heat in the conductor, and the rest is radiated into space in the form of electro-magnetic waves, and, as we know, the energy of these waves may be sufficient to detect them on the opposite side of the earth.

EQUIVALENCE OF MASS AND ENERGY.

We must now consider some further important extensions of our ideas of energy and its transformations, which belong to the present century and exert to-day a profound influence on the progress of atomic physics. We have seen that one of the great advances of the last century was the recognition of the relation between heat and energy; so to the present century belongs the recognition of a fundamental relation between mass and energy. The existence of such a relation was first discussed by Hasenöhrl in a study of the properties of radiation, but the general formulation of the principle we owe to Einstein in 1905, as a consequence of the theory of relativity. On this principle, mass and energy are equivalent, and mass is to be regarded in a sense as a concentrated source of energy. The energy E, whether in potential or kinetic form, resident in a mass m, is given by $E=m c^2$, where c is the velocity of light. If the energy of a system is increased, its mass is increased; if the energy decreases, the mass diminishes. For example, the mass of a rifle bullet in flight is slightly greater than at rest because of its additional kinetic energy. The mass of a body increases when it is heated, because its content of energy is increased. In these cases, when we are dealing with matter in bulk, the changes of mass brought about by realisable changes of energy, are exceedingly minute, and quite beyond the possibilities of measurement. For this reason, it might be thought that the effect of the change in mass is on such a small scale that it may be disregarded. This is not so, for we shall see that the position is very different when we deal with flying particles like electrons and protons, which can be given speeds comparable with the velocity of light. At slow speeds, the mass of the electron is only 1/1840 of the mass of our lightest atom, hydrogen, but its mass increases rapidly with speed as we approach the velocity of light. Even for the fast electrons that are spontaneously liberated from the radio-active bodies, the mass of the electron is five or six times greater than for slow speeds. This change of mass is much greater when we examine the very energetic electrons which appear in the cosmic rays. Some of these have a mass greater than that of the hydrogen atom, and still more energetic and consequently more massive electrons are believed to be present.

The conclusion that the destruction of mass involves the appearance of a corresponding amount of energy has been experimentally verified in a number of cases and is brought out with great clearness in investigations on the transformations of atomic nuclei. In discussing the changes of energy involved, it is customary to employ a special, but easily understood, unit of energy called the electron-volt. For example, the energy required by an electron in passing freely in a vacuum between two points differing in potential by 1 million volts is said to be 1 million electron-volts, or, for brevity, 1 million volts. On this unit the energy equivalent to the rest mass of the electron is 500,000 volts, and for the proton 940 million volts. It is convenient to remember that the energy corresponding to mass 1 on the atomic scale is 939 million volts, so that 0·001 difference in mass corresponds to slightly less than 1 million volts.

If as a consequence of a nuclear transformation the resulting masses of the particles are less than before, then, if the conservation of energy is to hold, the liberation of energy whether in the form of kinetic energy of the particles or in the form of radiation must be equivalent to the change of mass. Consider, for example, the transformation which occurs when the lithium isotope of mass 7 is bombarded by a stream of fast protons. Occasionally, as the result of a close collision, the proton enters the lithium nucleus and is captured by it. The new nucleus formed is unstable and breaks up with explosive violence into two α particles (helium nuclei), each of mass 4, which escape with high speed in nearly opposite directions. The transformation is schematically shown below :—

$$ {}^{7}_{3}\mathrm{Li} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{4}_{2}\mathrm{He} $$

where the subscripts represent the charges on the nuclei. From a measurement of the speed of the particles and allowing for the kinetic energy of the bombarding proton, it is found that the total kinetic energy liberated in this reaction is 17·1 million volts, equivalent to a loss of mass of the system 0·0181 volts. The relative masses of the atoms involved have all been carefully measured by Aston and Bainbridge by means of a sensitive instrument called the mass spectrograph, and are found to be H=1·0078, He=4·00216, Li=7·0146.† The difference in the sum of the masses on the two sides of the equation, viz., 8·0224 and 8·0043 is 0·0181. This, as we have seen, is in complete accord with the mass equivalent of the kinetic energy released. It is thus clear that the conservation of energy, taking into account changes of mass, holds for this nuclear reaction within the limit of the experimental errors. Incidentally, it should be mentioned that the conservation of momentum and also of nuclear charges equally hold in the transformation.

Similarly, when heavy hydrogen ions of mass 2 (deuterons) are used to bombard the isotope of lithium of mass 6 the following transformation occurs :—

$$ {}^{6}_{3}\mathrm{Li} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{4}_{2}\mathrm{He}. $$

Again, two α particles are shot out in opposite directions and with still greater speed than in the first case. The kinetic energy liberated is 22·5 million volts and again this is found to correspond to the decrease of the mass of the system.

In these reactions the released energy appears in the kinetic form and it is of interest to refer to another type of transformation of ^{7}Li bombarded by protons in which the greater part of the energy is liberated not in the kinetic form, but as a quantum of high energy radiation $h\nu$, viz.:—

$$ {}^{7}_{3}\mathrm{Li} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{8}_{4}\mathrm{Be} + h\nu $$

$$ \text{or} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{4}_{2}\mathrm{He} + h\nu. $$

It is not quite certain which of these reactions occur. The mass of the ^{8}Be isotope is known from other reactions and the quantum energy of the γ-radiation is found to be very great, viz., 16 million volts—about the value to be expected on the conservation of energy. While it appears that, in general, the energy released in a reaction is mainly in the kinetic form, it is of great interest to find such a clear case where the greater part of the energy can be released in the form of electromagnetic radiation of high quantum energy.

It is also found in general that every type of reaction takes place which is consistent with the conservation of energy. This is well illustrated by the many different types of transformations observed in the isotopes of lithium when bombarded by protons or deuterons.

While the conservation of energy appears to hold in all cases where the energy is associated with massive particles, it is by no means so certain that the law holds when light particles like positive or negative electrons are liberated in transformations. It is to be expected that the electrons should ordinarily be expelled with identical speed, but in all cases examined they are found to be released with a wide range of velocity. This peculiarity was first observed in the β-rays from the radioactive bodies and cannot be explained by supposing that part of the energy of the electrons is converted into γ-rays. As far as our information has gone, it appears that the conservation of energy applies if the energy of the fastest electrons is taken as a measure of the energy lost by all the nuclei involved. Either the conservation of energy does not hold with such light particles as electrons, or part of the energy is carried off in some unknown form. For this purpose a new particle called the "neutrino" has been invented. This particle, which has no charge and small mass, is supposed to be emitted with the electron and share part of its momentum and energy, but we have no direct evidence of any kind of the existence of this hypothetical particle. This apparent breakdown of the law of conservation of energy is of very great interest and may prove of fundamental importance.

PRODUCTION AND DISAPPEARANCE OF MATTER.

A very remarkable case of the conversion of the whole mass of a particle into radiation has been recently observed. A few years ago the positive electron of small mass was discovered, and is now known to appear in certain transformations and to arise also in the passage of high energy γ-radiation through matter. These positive electrons have a very short life and disappear apparently due to their coalescence with a negative electron in their path. In such a case, the mass represented by both a positive and negative electron, corresponding to 1 million volts, disappears in a blaze of radiation. If at the moment of disappearance the electrons have slow speeds, the energy of the radiation should correspond to the combined rest energy, viz., 1 million volts, but it is to be expected that, in order to conserve momentum, two quanta of radiation should be emitted, each of 500,000 volts in opposite directions. Actually, a radiation of this energy is observed in such cases and, in addition, experimental evidence has been obtained that two quanta of this energy are simultaneously emitted.

Still another striking observation has been made, the inverse of the former, for under certain conditions pairs of electrons, positive and negative, are produced by the action of high-frequency γ-rays. Since the combined energy of formation of two electrons is 1 million volts, the quantum energy of the radiation must be greater than this to be effective. Apparently, the production of such electron pairs is due to the interaction of the high energy radiation with the electric field outside a nucleus, and is specially marked for heavy nuclei.

This is the first time that evidence has been obtained that matter, or, at any rate, individual massive entities, can be produced by the action of radiation. There is also some indication that this materialisation can be effected also by high energy electrons. Under certain restricted conditions, it thus appears that mass and energy are mutually convertible. So far no evidence has been obtained that the mass of the proton can vanish into radiation. If this process can occur, the total energy of the radiation emitted should be nearly 1000 million volts. It appears in general that the conversion of mass into energy or the conversion of energy into mass are most likely to take place when we are dealing with very concentrated sources of energy such as occur in the energetic particles present in the cosmic rays. Some of these are of far greater energy than we can hope to produce in the laboratory, so a close study of the effects produced by the cosmic rays may give us further information on this most fascinating and fundamental problem.

ENERGY LIBERATED IN TRANSFORMATIONS.

It has long been known that the atoms of the natural radioactive bodies break up with the emission of a large amount of energy generally in the form of a fast α or β particle. Some of the atoms which are broken up artificially by bombardment with protons or deuterons emit even more energy than the atoms of the radioactive elements. In the case of artificial transmutations, we can, however, compare the kinetic energy of the bombarding particle with the amount of energy released in the transformation. The efficiency of bombarding particles in producing transformations in general increases rapidly with the kinetic energy of the particles. For example, the transformation of lithium by protons of energy, say, 1 million volts, is on a very marked scale, but is still detectable with protons of energy as low as 20,000 volts. Since the energy liberated in the transformation of each atom is about 17 million volts, the energy released is about 850 times the energy communicated to the atom. On the other hand, we must bear in mind that only 1 proton in 10^{8} is effective, so that on the whole far more energy is supplied than is gained. While the overall efficiency of the process arises with increase of energy of the bombarding particles, there seems little hope of gaining useful energy from the atoms by such methods. On the other hand, the recent discovery of the neutron and the proof of its extraordinary effectiveness in producing transformations at very low velocities, opens up new possibilities, if only a method could be found of producing slow neutrons in quantity with little expenditure of energy. At the moment, however, the natural radioactive bodies are the only known sources for obtaining useful energy from atoms, and this is on far too small a scale to be of more than scientific interest.

† Recent work indicates that these masses are too low, but the mass differences on which the energy depends remain the same.

A Small Cutter Grinder.

A SMALL grinding machine for grinding the cutters used on engraving machines, which will be put upon the market in a few weeks' time by Taylor, Taylor and Hobson, Ltd., of Stoughton Street Works, Leicester, is shown in the accompanying engraving. As will be seen, a cup wheel is used and is driven by a gut belt from a motor housed in the pedestal. It is mounted on a ball-bearing spindle. The tension in the belt can be adjusted. In front of the wheel there is mounted a compound slide rest, which also has a swivelling motion, and a V-rest for the tool to be ground. There is a gauge for setting the cutter and a set of stop cams to ensure the accuracy of the grinding operations. The feed screw is graduated in thousandths of an inch, so very precise dimensions can be worked to. The slides, motor, and screws are protected from grit and provision is made for taking up normal wear of the parts. By means of additional fixtures, not shown in the illustration, twin-edged flat cutters can be ground.

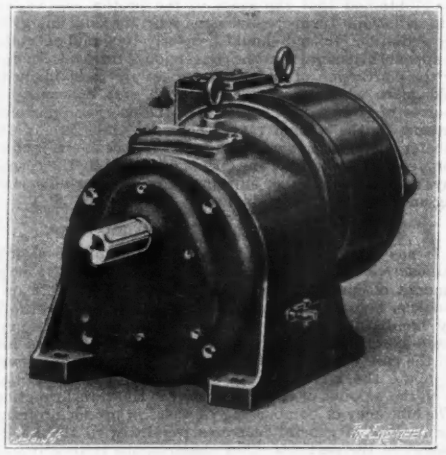
SMALL CUTTER GRINDER

The machine is also supplied without the housing

and motor for use in conjunction with the makers' C.X. engraving machine, when it is driven by a band from a motor at the base of the machine. The makers inform us that they are also developing other machines for grinding ball-ended cutters, counterbores, and other small workshop tools.

Electric Motor Gear Units.

THE range of reduction gear units for use in conjunction with electric motors has recently been extended by Higgs Motors, Ltd., of Birmingham, to cover outputs up to 10 h.p. at 100 r.p.m., or a lower final speed with a corresponding reduction in horse-power. A unit designed to give a maximum output of approximately 1 h.p. at 50 r.p.m. was introduced by the firm about twelve months back, and the larger units are of similar construction. All gear wheels, with the exception of one in the first high-speed reduction, are composed of high-carbon steel. The use of a fabric composition for the high-speed wheel and the fact that all wheels are generated on Fellows gear shapers are said to have resulted in the production of



GEARED MOTOR UNIT

units that are both efficient and commercially silent in operation. Special features claimed for the design are that the body casing is in one piece and as there are no joints between the feet, distortion does not result from unequal bolting down. All gear wheels, with the exception of the first, run between deep groove ball bearings, carried in a cast iron cage machined independently of the main body casting, and giving accurate gear alignment coupled with silent working. All units have an oil level tap and drain plug, and an inspection cover in the case of the larger sizes. The units are said to be absolutely oil-tight. Double-reduction units are stated to have an efficiency of 96 per cent., and triple-reduction units 94 per cent. With the oil taps, &c., are fitted in suitable positions, the units are supplied for floor, wall or ceiling mounting. All the parts comprising motor, gear-box, and gears, are made by Higgs Motors, and not, as is generally the case, by separate firms.

The Quarter's Shipbuilding Returns

THE statistics issued by Lloyd's Register of Shipping regarding merchant vessels under construction at the end of December last show that in Great Britain and Ireland there is an increase of 212,532 tons in the work in hand, as compared with the figures for the previous quarter. The present total of tonnage under construction—743,086 tons—is 146,252 tons more than the tonnage which was being built at the end of December, 1934, and is the highest quarterly total recorded since December, 1930. Moreover, it exceeds the aggregate tonnage now under construction in the seven leading countries abroad. The tonnage on which work was suspended at the end of December last amounted to 14,288 tons, being composed entirely of steamers. About 122,000 tons, 16·4 per cent. of the tonnage now being built in this country, are intended for registration abroad or for sale.

The tonnage now under construction abroad, excluding Russia, for which no figures are available (800,067 tons) is about 133,000 tons more than the work which was in hand at the end of September last. Tonnage, included in the total in hand abroad, on which work has been suspended amounts to 5050 tons of steamers and 5975 tons of motor ships. The leading countries abroad are:—Germany, 254,121 tons; Japan, 118,610 tons; Holland, 104,325 tons; Sweden, 94,802 tons, Denmark, 61,085 tons; and France, 56,078 tons. The total tonnage under construction in the world amounts to 1,543,153 tons, of which 48·2 per cent. is being built in Great Britain and Ireland, and 51·8 per cent. abroad. The quarterly total for the world shows an increase of 345,184 tons over the figures at the end of September last, and is the highest recorded since June, 1931.

In Great Britain and Ireland 311,100 tons were commenced during the last three months, an increase of 192,121 tons compared with the corresponding total for the September quarter. During the quarter ended December, 1935, 132,139 tons were launched in Great Britain and Ireland, an increase of 19,299 tons as compared with the previous quarter. Similar figures for abroad are 276,112 tons commenced, and 226,397 tons launched, showing, as compared with the previous quarter, increases of 90,260 tons in the tonnage commenced and of 75,770 tons in the tonnage launched.

Steam and motor oil tankers under construction in the world amount to fifty-nine vessels of 438,560 tons, of which fifteen vessels of 114,040 tons are being built in Great Britain and Ireland, eleven vessels of 101,700 tons in Germany, six vessels of 52,264 tons in Sweden, ten vessels of 47,835 tons in Holland, four of 29,665 tons in Japan, four of 28,200 tons in the United States of America, three of 25,200 tons in Denmark, and two of 16,736 tons in France. Of the 743,086 tons under construction in Great Britain and Ireland at the end of December, 376,714 tons consisted of motor ships, while at the same date the motor ship tonnage being constructed abroad, 520,822 tons, was 244,973 tons in excess of that of the steamers.

The vessels being built in the world at the end of December include one steamer and twenty-four motor ships of between 8000 and 10,000 tons each; eight steamers and twenty motor ships of between 10,000 and 20,000 tons; one steamer and two motor ships of between 20,000 and 30,000 tons; and two steamers exceeding 30,000 tons each. The table respecting marine engines shows that the horse-power of steam engines now being built or being fitted on board amounts to about 587,000 h.p. This figure includes forty-nine sets of turbine engines of about 363,000 s.h.p. The horse-power of the steam reciprocating engines, about 225,000 h.p., amounts to 15·7 per cent. of the total horse-power of marine engines now being built in the world. The figures for oil engines aggregate approximately 840,000 h.p.

Of the merchant shipbuilding in hand throughout the world at the end of December, 1,099,600 tons, or over 71 per cent., are being built under the inspection of Lloyd's Register. Of this total, 670,232 tons, representing more than 90 per cent. of the tonnage being built there, are under construction in Great Britain and Ireland; while, of the tonnage being built abroad, 429,368 tons, or 53·7 per cent., are being constructed under the inspection of Lloyd's Register.

Unemployment and Foreign Trade.*

TOUCHING unemployment there are no reliable figures; but all the experts I met seemed to think that the numbers of the unemployed had not fallen much, if at all, during the year. The most plausible explanation was that employers had preferred to put their men on to full time, rather than add inferior workmen to their pay rolls. Thus, profits and production had increased without causing much visible increase of employment. In New York and other great ports the amount of unemployment is appalling, and it is admittedly due to the severe shrinkage of foreign trade. This is attracting more and more the attention of the shipping interests. Importers and exporters have come to feel that their interests are identical, and shipowners, of course, realise not only that imports and exports rise and fall together, subject to irregular movements of capital, but also that imports of gold are a very poor substitute for imports of bulky articles.

The American Manufacturers' Export Association† has issued recently a large pamphlet, illustrated with effective diagrams, on "Foreign Trade and Domestic Markets." It is not a dry summary of statistics, but an attempt to go behind them to the vital factors of American economics, and of the Government's programme, which demand "a consideration of the geographical, agricultural, and industrial distribution of foreign trade" and its relation to the total mass of unemployment. The Association is fortunate in an able body of Directors, and an active Executive. Its President, Mr. James Mooney, is in charge of the overseas business of the General Motors Corporation. What he and his colleagues have discovered is that the interests of the export trade are bound up with those of the import trade. They see that American industry needs wider markets and a freer exchange of goods and services. They hold that governmental regulations should be confined to the elimination of unfair practices, and that stabilisation of money should be promoted by a more liberal commercial policy. Crop reductions should be discontinued, and increased agricultural exports should be stimulated by facilitating imports. They boldly proclaim the desirability of an unfavourable trade balance, and heartily support Secretary Hull's reciprocity agreements. They argue that restrictions on foreign trade by a prohibitive, or almost prohibitive, tariff involve agricultural subsidies, regimentation of industry, and permanent large unemployment.

To illustrate these propositions, they compare the value of the export trades of various States in 1929 and 1932. The exports of Texas—to take the worst case—dropped in value from 658 million dollars to 300 million dollars—the loss amounting to 120 dollars per family. Taking a seven-year average from 1927 to 1933, they show that in the case of cotton 56 per cent. of the total production was exported, in the case of motor cycles 54 per cent., of typewriters 40 per cent., of tobacco leaf 39 per cent., of office appliances 28 per cent., of agricultural machinery 24 per cent., of wheat 18 per cent., of sewing machines 23 per cent., &c. As for the foolish notion that it is better for employment to export finished goods than raw materials, they point out that "it takes a lot more people to grow, pick, bale, transport, gin, sell, and buy raw cotton per thousand dollars, than it does to make, pack, sell, transport, and export a thousand dollars' worth of sewing machines."

Then they make careful calculations of the amount of labour and employment in the United States that is dependent on imports and exports, taking the 1930 census. Their conclusion is that, out of 48 millions gainfully employed in the United States before the depression, about seven millions were directly or indirectly dependent on exports, and about the same number on imports. Roughly speaking, the proportion thus dependent was therefore as 14 to 48—a good deal more than a quarter.

As for the idea that larger imports of manufactured goods would displace labour, they retort that if dock labour, transport, &c., is allowed for, the imported manufactured article on the average "actually creates more employment in the United States than the exported manufactured article."

Among the members of President Roosevelt's Administration no one sees so clearly as Mr. Cordell Hull that this problem admits of only one solution. The height of the customs wall which has been built up round the American ports must be reduced in order to admit a larger volume of imports in exchange for a larger volume of exports. A general reduction might have been effected after President Roosevelt assumed office. If he had acted then, he might have saved the London Conference and made it a landmark of progress instead of an emblem of failure, an example instead of a warning. But progress is now being made by means of the reciprocity treaties which Mr. Cordell Hull has been negotiating. Until a few weeks ago, the most important of these was with Cuba; tariffs and quotas were lowered, and the results in the first year were significant. By reducing the tariff on Cuban produce, Mr. Cordell Hull raised the revenue from 47 to 67 million dollars. If the old democratic principle of a tariff for revenue only were applied to the whole tariff of the United States, a great increase of the customs revenue would undoubtedly result, along with a still greater increase of imports and exports.

Far more important than the Cuban Treaty is the reciprocity treaty with Canada, which was signed while I was at Washington. Canada comes close after Great Britain in the order of America's foreign customers, and although the most-favoured-nation clause gives most other countries, including Great Britain, the advantages of the lowered tariff rates, American and Canadian producers will, of course, reap the chief benefit, just as French and British producers gained most by the Cobden Treaty of 1860. It was predicted at Washington that the commerce over the Canadian border would be doubled. This may prove an exaggerated estimate; but it is no exaggeration to say that the treaty is the biggest step towards commercial freedom that has been taken by any two nations since the Great War. I can therefore close my impressions on a hopeful note.

* From a paper by Francis W. Hirst in *Lloyds Bank, Ltd., Monthly Review.*

† Its executive offices are at 330, West Forty-Second-street, New York.

SIXTY YEARS AGO.

WE recall this week an accident at Abbots Ripton on the Great Northern Railway which evoked much comment at the time because it revealed a previously unsuspected defect in the design of railway signals. During a snowstorm in the early evening of Friday January 21st 1876 a coal train consisting of thirty-three wagons was being shunted at Abbots Ripton to allow the up Scotch express to pass. Before the operation was completed the express approached at full speed and struck one of the wagons of the coal train. The wagon was smashed to pieces, the express engine was derailed and the carriages following it were heaped on one another and upset. Many of the passengers in the Scotch express were entangled in the wreckage and while efforts were being made to free them railway officials ran along the line placing fog signals in position to stop the approach of other trains. The signalman in the nearest box, made aware of the accident, also took steps to stop all traffic. Nevertheless a down Leeds express ran over the fog signals and in spite of every effort made by its driver crashed into the wreckage at a speed of between 25 and 30 miles an hour. The engine of the Leeds train was overturned. It was never made clear whether any lives were lost when the Scotch express ran into the coal train or whether any of the passengers in the Leeds express were killed. All that was known with certainty was that as a result of the double mishap thirteen passengers lost their lives and fifty-three suffered injury. Probably all or most of the fatalities were suffered by passengers in the Scotch express when the Leeds express ran into its wreckage. The Board of Trade inquiry was conducted by Captain Tyler. He assigned no fewer than twelve co-acting causes to the mishap. The outstanding one, however, was the fact that all the signals concerned had failed to act. The coal train was late and an effort had been made to stop it for shunting before it reached Abbots Ripton. Its driver however ran past the signal which although operated to show stop was observed still to exhibit a white light. The shunting was postponed until the train reached Abbots Ripton at which box the signalman protected the train by operating his levers to set the signals against the Scotch express. Once again the signals failed to respond and the first collision occurred. Similarly the protection which the signalman gave the wreckage against the Leeds express was ineffective because of the failure of the signals to respond. The first intimation that anything was wrong which the driver of the Leeds express received was the explosion of the fog signals. Although the first of these fog signals was exploded at a distance of 1136 yards from the wreckage, the brakes with which the Leeds express was fitted were not powerful enough to pull it up in time. They were of the hand type. The fitting of continuous brakes had not at that date been made compulsory on all passenger trains, the publication of the Railway Commission's report on the subject having been unduly delayed. The failure of the signals to respond to the movement of the levers was ascribed to the fact that the semaphore arms had been kept lowered for some time during the snowstorm with the result that snow had become wedged and frozen on them to such an extent that the balance weights were unable to move them to "danger" when the pull of the signal wire was released.

AT a recent meeting of the Midland Institute of Mining Engineers, Messrs. H. J. Atkinson and G. Allsop gave details of an equipment for lighting the coal face from the power mains in use at the Steetley Colliery of the Shireoaks Colliery Company. The face is 260 yards long, and the seam is 4ft. 2in. thick. Along this face electric lamps have been installed at 9 or 10-yard intervals. There had been a continuous reduction in the number of accidents as the lighting had been extended, and the steady decline in the number of compensation cases was most marked. The average cost of a compensation case on the face had been £2·85, and the number of cases per month had fallen from 6½ to 1½, representing a saving of 0·3d. per ton.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

British Steel Export Prices.

The death of King George V has naturally cast a shadow over all markets, and for a time at least business is likely to be somewhat restrained. The production of iron and steel in Great Britain, however, is on a record scale, and the makers have sufficient orders on their books to maintain the present rate of operations for some months. The demand continues to be principally on home account, and although now and again the export trade develops a show of activity, its progress has been disappointing. Meetings of the British and Continental steel makers were held at the end of last week in Paris, at which it is understood export questions were discussed, and it is interesting to note that the British steel makers, immediately prior to the meetings, raised their export prices for structural material for all markets excepting Canada, India, South Africa, Australia, and New Zealand, by 5s. For the markets mentioned prices remain unaltered. This makes the second recent price advance on export account, the last change being in the first week of November, when there was a general increase in export prices of half-a-crown. Perhaps one of the most interesting developments in the overseas trade situation is the demand by South African steel makers that the British and Continental works should submit to a quota for that market. The South African industry seems to have adopted with enthusiasm the policy of the British makers with regard to their home market, and just as the British offered the Steel Cartel the opportunity of charging higher prices to British consumers as compensation for drastically reduced imports, so the South Africans are making similar proposals to the British and Continental industries. These, apparently, have not been well received by the Cartel, and this may be readily understood, as the British export trade alone to South Africa during 1935 amounted to 291,906 tons, valued at £4,489,127.

Our Iron and Steel Imports.

The Board of Trade Returns for December, which include the import and export figures for the year 1935, enable some interesting comparisons to be made. The total exports of iron and steel and manufactures thereof reached 2,371,914 tons, compared with 2,250,527 tons in 1934, whilst the imports amounted to 1,152,046 tons, against 1,366,221 tons in the previous year. The imports, however, increased from 76,999 tons in November to 112,993 tons in December. The pig iron imports last month reached 8910 tons, compared with 4459 tons in the previous month. Of the former total 6860 tons came from British India. The imports of blooms, billets, and slabs, which, in November, totalled 21,582 tons, in December increased to 34,140 tons, of which Belgium supplied 11,130 tons and France 9778 tons. There was a noticeable increase in the imports of sheet bars from 4862 tons to 10,132 tons in December, of which 9865 tons came from Belgium. There was, however, a decrease in the quantity of girders, beams, and joists brought into the country from 6707 tons in November to 5982 tons last month. The largest quantity came from France, which sent 2548 in December, whilst 2246 tons came from Belgium. There was little difference in the quantities of hoop and strip imported in the two months under review. In November 4590 tons came in, whilst the imports in December totalled 4758 tons. Imports of plates and sheets in December showed a decline to 4004 tons from 4664 tons in the previous month. There was a sharp drop in the imports of wire nails last month to 1354 tons, compared with 1685 tons in November. The decline was due to smaller quantities coming from British countries. These totalled 611 tons in November, but fell in the following month to 221 tons. It is interesting to note that for the year 1935 Belgium was the largest supplier with 517,654 tons, France coming next with 164,541 tons, and Luxemburg next with 109,509 tons. Imports from Germany fell from 145,225 tons in 1934 to 77,813 tons last year. Norway was one of the few countries which increased her exports to Great Britain, the total for the year being 32,658 tons, compared with 25,451 tons in 1934. The imports from British countries, however, rose from 82,788 tons in 1934 to 91,893 tons in 1935.

The Export Figures.

Although the exports for the year were appreciably better than in 1934, the total for December compared badly with that for November. In December 190,308 tons were exported against 215,835 tons in November. The decline was spread over most descriptions of iron and steel. The exports of pig iron fell from 13,121 tons in November to 9308 tons last month. The exports of steel bars, rods, angles, and shapes were maintained, however, the total for last month being 19,253 tons, compared with 19,781 tons in November. Of the quantities exported last month, 5882 tons went to British India and 3548 tons to South Africa. There was only a slight decline in the exports of girders, beams, joists, and pillars, which, in November, amounted to 2816 tons and in December to 2377 tons. A noticeable fall occurred in the exports of hoop and strip from 4854 tons in November to 3645 tons in the following month. On the other hand, there was an increase in the exports of plates and sheets not under ¼in. thick to 15,138 tons in December from 13,829 tons in the previous month. Plates and sheets under ¼in. thick were exported to the extent of 12,898 tons, the figure for November being 13,200 tons. Of the December exports 4600 tons went to the Argentine, India taking 1693 tons. Exports of tubes fell during December to 20,866 tons, against 22,815 tons in the previous month. A noticeable decline was registered in the exports of railway material, which dropped from 22,184 tons in November to 13,672 tons last month. Taking the figures for the whole year, South Africa was the largest buyer of British iron and steel materials with 291,906 tons. India took 281,046 tons, Canada 158,843 tons, and Australia 158,709 tons. Of foreign countries exports to the Argentine totalled 132,768 tons, Denmark coming second with 115,155 tons, and Russia next with 70,239 tons. Amongst other countries which were important buyers of British iron and steel last year were Holland, 74,468 tons; Egypt, 47,295 tons; China, 45,271 tons; Persia, 44,569 tons; Brazil, 25,659 tons; United States, 20,681 tons, and Japan, 20,615 tons.

The Pig Iron Market.

The position in the pig iron market would warrant an expansion in production, but it is unlikely that steps will be taken to increase the number of furnaces in operation until the coal dispute has been definitely settled. The uncertainty regarding the future costs of production as a result of dearer fuel must necessarily hold up business for a time. Already the price of coke has advanced, whilst the quotation for foreign ore has also become firmer. In these circumstances it is not surprising that the producers do not wish to sell forward, and probably they are strengthened in this attitude by the fact that the majority of consumers already hold contracts for delivery over the first six months of the year. On the North-East Coast little new business has been transacted, and the makers are supplying deliveries against running contracts by drawing upon their stocks. Only two furnaces are producing foundry iron in this district, but it is reported that other furnaces are being prepared so that they can be quickly put into operation when a settlement of the coal dispute is reached. The heavy demand from the steel works for basic and hematite iron resulting from the shortage of scrap has led to the concentration of production upon these qualities, so that there has been a consequent heavy fall in the output of foundry. In the Midlands a heavy tonnage of foundry iron is passing into consumption, and although considerable stocks are said to exist at some of the Derbyshire furnaces, the production of Northamptonshire iron is scarcely sufficient to meet users' requirements. In the Lancashire district there has been a certain amount of business in contract renewals, but the majority of consumers are well covered and are content to draw against their contracts. New business, therefore, in this district has not been heavy. In Scotland twelve furnaces are in operation, and the full production is passing into consumption. As in other districts, however, the producers are not keen to accept new business until the coal outlook becomes clearer. The light castings foundries continue to take good quantities, and the requirements of the engineering foundries also appear to be expanding. Business in hematite has been confined largely to supplementary orders, as the steel works for the most part have contracted for some time forward. The scarcity of scrap, however, has created an increased demand for hematite.

The North-East Coast and Yorkshire.

All the works in this district are actively employed, and apart from the threat to the continued development of business offered by the coal dispute, the outlook has rarely been more promising. The situation in the semi-finished steel market seems likely to be relieved by the importation of increased supplies of Continental semi-finished steel. Although the steel works in this district are operating almost at capacity they are unable to satisfy the markets' requirements of semis, and in many cases are behind-hand with deliveries. It is reported that an increase in the production of this class of material may be arranged in the near future; but for the time being the market is badly in need of larger supplies of billets and sheet bars. There has been no change in the quotations, the British official price for billets being £5 10s. for untested quality in 500-ton lots, 100 tons of a size. The rail mills, which have not been fully employed of late, are expecting to receive some important new business. The shipbuilders on this coast, also, are in a better position than for a long time, and their increased requirements are providing a heavy tonnage of fresh work for the steel makers. Constructional engineers are busily occupied and there is a considerable amount of new business in prospect. The requirements of this branch, therefore, show no signs of declining, and are sufficient to tax the resources of the structural steel mills. The sheet makers are experiencing a good home demand, but the volume of export business remains disappointing, although lately there has been a slight revival in the overseas demand for black sheets. In Yorkshire the steel works are now operating at as high a rate as before the holidays. The production of basic steel does not diminish and there is no lack of fresh business in this department. A heavy tonnage of basic billets is passing into consumption, and more business is on offer than the makers can see their way to accept. The demand for acid billets also is slowly expanding, and the quotations for the latter are unaltered at £6 15s. for rivet forgers' quality up to £11 7s. 6d. for billets 1·5 to 2 per cent. carbon content.

Current Business.

It is announced that the Jarrow steel works scheme will be proceeded with and that the option holders have definitely decided to take over the entire works and shipyard site of Palmers Works. These were purchased by Thos. W. Ward, Ltd., some time ago, and will be disposed of to the new undertaking which, it is reported, will have a capital of over one million pounds. The dismantling of the old works will be accelerated in order to make room for the new iron and steel plant. The Albion Chemical Works, West Cornforth, which include tar stills, and were formerly owned by Dent, Sons and Co., Ltd., have been taken over by Henry Stobart and Co., Ltd., who own the adjoining Thrislington (Cornforth) Colliery. Hughes, Bolckow Shipbreaking Company, Ltd., Blyth, have bought for breaking up at a price of £15,000 the French steamer "Cephee" (9680 tons). The Ford Company of Windsor, Ontario, have placed an order with C. A. Parsons and Co., Ltd., of Newcastle-on-Tyne, for a condensing turbo-generator plant of 20 kW and a non-condensing generator set of 5000 kW. The Clyde Shipbuilding Company, Ltd., have placed an order with Alex. Stephen and Sons, Ltd., Linthouse, for a passenger and cargo steamer of 1600 tons gross. The Anglo-American Oil Company have placed an order for twenty-four tank wagons with Hurst, Nelson and Co., Ltd., of Motherwell. The London and North-Eastern Railway Company is expected to commence the work of electrifying the Newcastle–South Shields line in April. It is anticipated that the cost will be about £500,000. The Laygate Foundry, South Shields, belonging to Charles W. Taylor and Sons, Ltd., is to be reopened shortly after having been closed for five years. It is announced that Mr. Malcolm Stewart, Commissioner for the Special Areas, has made a grant of one-third of the cost of the new Whitehaven Harbour improvement scheme, and a loan of the remaining two-thirds. The scheme is to improve the entrance to the docks so that 2000-ton vessels can be berthed. The Department of Overseas Trade announces that the following contracts are open for tender:—New Zealand Public Works Department: One 30,000 kVA transformer bank for the Penrose sub-station (three 10,000 kVA, oil-immersed, self-cooled, single-phase transformers with accessories) (Wellington, April 21st).

Copper and Tin.

Although the tone of the market remains fairly optimistic, business in electrolytic copper has been rather dull. It is stated that fundamentally the situation remains favourable; but there is perhaps a note of hesitation in these assertions. In the United States the confusion caused by recent legal decisions regarding the New Deal, naturally, has had the effect of slowing down the demand for copper as well as other commodities. The Continental situation also does not improve, and whilst there is no doubt that European consumers would be glad to replenish their stocks of electrolytic copper, the question of payment, import quotas, and similar restrictions to trade stand in the way. The requirements of consumers in this country are maintained but have shown no signs of expanding for some weeks. Looking at the position all round, it seems likely that consumption during the first three months of this year will not compare favourably with the last quarter of 1935. American statistics give the stocks of refined copper at the end of the year as 485,000 tons, of which 231,400 tons was in the United States. The world's production in December is placed at 132,500 tons. Business in the standard market has been rather uninteresting. Speculation is at a lower ebb than for several months past, and although the stocks tend to decrease this movement is not so rapid as it was in the closing weeks of last year. . . . Prices in the tin market have shown an easier tendency and sentiment is certainly not so buoyant as even a few weeks ago. The general opinion seems to be that powerful interests are endeavouring to maintain the forward price in the hope of preventing a collapse when the expected increase in the supplies of tin makes its appearance. It is even suggested that the efforts are directed towards keeping the three months' quotation above £200. This price, however, does not give much margin, since the quotation has already dropped to £203 7s. 6d. The backwardation continues to rule at between £8 and £9, but the market would not be surprised if it soon began to contract. It is expected that the statistics at the end of the month will show an increase of 1000 tons in the visible supply.

Lead and Spelter.

The persistent weakness in the lead market has proved disconcerting to consumers as well as dealers. The former rarely make substantial purchases on a declining market and dealers apparently thought that when the metal went below £18 the fall had been overdone and an upward reaction would take place. There is no doubt that the free selling by producers has been the primary reason for the decline in values, but a contributory cause has been that many of the contracts entered into about three months ago when the price was in the neighbourhood of £20 are maturing, and in cases where the holders do not wish to carry the metal it has been thrown on the market. This phase may last for a time, but there is no reason to suppose that the heavy demand noticeable before the holidays will not revive. Consumers in this country for the time being seem content to watch the market and the industrial demand for lead on the Continent also appears to be rather quiet. So much so, in fact, that the suggestion is heard that Continental users overbought their requirements and are not likely to re-enter the market for some weeks. The quantities of Empire lead reaching this country do not seem to be more than sufficient to meet contract commitments, and none of the metal apparently is available for the open market. Nothing is heard of any Mexican lead being offered for the British market. . . . The spelter market of late has displayed a firmer tone than most of the non-ferrous metal departments. It cannot be said that the demand has expanded or that the future holds out any greater promise than for some time past. There has, however, been sufficient buying by consumers to create a steady tone and there has been no selling pressure. It is said that stocks in consumers' hands are particularly low, but if this is the case they apparently feel there is no danger of a substantial upward movement, since there is no sign of replacement transactions on any scale. Fresh arrivals of Continental spelter are expected a little later in the month, but these are not likely to be more than normal and should not affect the market position, excepting possibly to cause the contango to widen a little.

Current Prices for Metals and Fuels.

Makers' official home trade prices per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. * For Markets other than Canada, India, South Africa, Australia and New Zealand 5s. per ton must be added.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. COAST—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 10 6	3 2 0
No. 1	3 11 0	3 3 6
Cleveland—	(*D/d Teesside Area*)	
No. 1	3 12 6	3 4 0
No. 3 G.M.B.	3 10 0	3 1 6
No. 4 Forge	3 9 0	3 0 6
Basic (*Less 5/– rebate*)	3 10 0	—
MIDLANDS—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 15 0	—
„ „ Forge	3 10 0	—
Basic (*Less 5/– rebate*)	3 15 0	—
Northampton—		
Foundry No. 3	3 12 6	—
Forge	3 7 6	—
Derbyshire—		
No. 3 Foundry	3 15 0	—
Forge	3 10 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 13 6	—
No. 1 Foundry, ditto	3 16 6	—
No. 3 Foundry, ditto	3 14 0	—
Basic, d/d (*Less 5/– rebate*)	3 10 0	—
N.W. COAST—	3 14 0	d/d Glasgow
Hematite Mixed Nos.	3 18 6	„ Sheffield
	4 4 6	„ Birmingham

MANUFACTURED IRON.

	Home.	Export.
LANCS.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. YORKS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
MIDLANDS—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
No. 3 quality	7 17 6	—
No. 4 „	8 10 0	—
SCOTLAND—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. COAST—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

	Home.	Export.
LONDON AND THE SOUTH—	£ s. d.	£ s. d.
Angles	8 10 0	*7 10 0
Tees	9 10 0	*8 10 0
Joists	8 17 6	*7 10 0
Channels	8 15 6	*7 15 0
Rounds, 3in. and up	9 10 0	*8 10 0
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¾in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 10 0	9 0 0
NORTH-EAST COAST—	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	*8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
„ under 3in.	8 12 0	7 10 0
Plates, ¾in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	9 0 0
Boiler Plates, ¾in.	9 5 0	—
MIDLANDS, AND LEEDS AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	*8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 5 0	9 0 0
Boiler Plates, ¾in.	9 7 6	7 15 0

STEEL (*continued*).

	Home.	Export.
GLASGOW AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	9 0 0
Boiler Plates	9 5 0	—
SOUTH WALES AREA—	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	*8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 10 0	9 0 0

IRELAND—	BELFAST.	REST OF IRELAND.
	£ s. d.	£ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¾in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G. to 13-G., f.o.r.	9 15 0	9 0 0
14-G. to 20-G., d/d	11 5 0	9 10 0
21-G. to 24-G., d/d	11 10 0	9 15 0
25-G. to 27-G., d/d	12 2 6	10 7 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24

Home.	£ s. d.
4-ton lots and up	13 10 0
2-ton to 4-ton lots	13 17 6
Under 2 tons	15 10 0

Export: £12 15s. 0d., c.i.f. India.
„ £11 15s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.

20 by 14 basis, f.o.b. Bristol Channel Ports, 18s. 9d.
Tin-plate Bars, d/d South Wales Works, £5 10s. 0d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 to 250 tons	5 17 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 0 0	7/–
„ „ 8 p.c. to 10 p.c.	£21 0 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£33 10 0	11/–
„ „ „ 1 p.c. carbon	£36 5 0	11/–
„ „ „ 0·50 p.c. carbon	£37 5 0	12/–
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose), 76 p.c.	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, January 22nd.

COPPER—		
Cash	£34 18 9 to £35 0 0	
Three months	£35 6 3 to £35 7 6	
Electrolytic	£39 0 0 to £39 10 0	
Best Selected Ingots, d/d Birmingham	£38 15 0	
Sheets, Hot Rolled	£66 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10½d.	10½d.
„ Brazed (basis)	10½d.	10½d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£32 0 0 to £33 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9¾d.	9¾d.
„ Brazed	11¼d.	11¼d.
TIN—		
Cash	£207 0 0 to £207 10 0	
Three months	£198 15 0 to £199 0 0	
LEAD	£15 2 6 to £15 3 9	
SPELTER	£14 5 0 to £14 11 3	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

LANARKSHIRE—	Export.
(f.o.b. Grangemouth)—Navigation Unscreened	18/– to 18/6
Hamilton Ell	19/– to 19/6
Navigation Splints	20/– to 21/–
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/– to 16/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	17/– to 17/6
Unscreened Navigation	18/– to 18/6
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime	17/6
Secondary Steam	17/–

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	19/6 to 23/–
Furnace Coke	14/6 to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	15/6 to 16/6
„ Second	14/6 to 15/–
„ Best Small	11/–
Unscreened	13/– to 14/6
DURHAM—	
Best Gas	14/8
Foundry Coke	19/- to 20/–

SHEFFIELD—	Inland.
Best Hand-picked Branch	26/– to 28/–
South Yorkshire Best	23/– to 25/–
South Yorkshire Seconds	20/– to 21/–
Rough Slacks	11/– to 12/–
Nutty Slacks	10/– to 11/–

CARDIFF— SOUTH WALES.	
Steam Coals:	
Best Admiralty Large	19/6
Best Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Bunker Smalls	12/6 to 13/6
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 27/6
Foundry Coke	27/– to 40/–
Furnace Coke	19/– to 22/6
Patent Fuel	21/–
SWANSEA—	
Anthracite Coals:	
Best Large	36/– to 40/–
Machine-made Cobbles	45/– to 48/6
Nuts	40/– to 48/6
Beans	25/– to 30/–
Peas	19/– to 23/–
Rubbly Culm	11/6
Steam Coals:	
Large Ordinary	18/- to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

French Engineering Notes.

(From our own Correspondent in Paris.)

Reciprocal Trading.

A COMMERCIAL agreement has been signed with Russia whereby imports into France are regulated by quotas and the Soviet Government undertakes to place orders with French manufacturers equal in value to the purchases of Russian products during any one year. In this particular case the arrangement may offer the only guarantee against a repetition of failures in the past to secure a fair balance of trade between the two countries, but it is noteworthy in being the only occasion on which France has succeeded in negotiating a strictly reciprocal treaty, mainly in the interests of her manufacturing industries. Rumours to the effect that France will make a loan to the Soviet Government in order to finance its purchases have not been confirmed. In all other cases where the French have endeavoured to impose the law of reciprocity without most-favoured-nation treatment, arrangements have been of a partial character or negotiations have been suspended. On the other hand, almost simultaneously with the Franco-Russian agreement a commercial arrangement on the basis of most-favoured-nation treatment was signed by Switzerland and the United States. The significance of this latter agreement lies in the fact that the advantages offered to Switzerland by the clause tend to divert business from France, and it also implies that the conflict between the French system of reciprocity with preferential treatment to individual countries and the most-favoured-nation clause has gathered strength by American intervention.

Foreign Trade.

The fact that imports during 1935 were down by 2152 million francs and exports declined by 2377 million francs as compared with figures for the previous year affords a striking commentary on the present unsatisfactory economic condition of the country, for there is little compensation in internal activity except that provided by State requirements and work undertaken with State assistance. Private enterprise lies dormant because money will not circulate in times of economic and political uncertainty, and the dearness of what money is available renders its use unprofitable for industrial undertakings. Everyone admits that there can be no solution of the difficulty except by an expansion of foreign trade which will give vitality to exporting industries and help to relieve the financial burden on others, but the fear of doing anything that may endanger some interests stands in the way of any commercial policy that may involve certain sacrifices. The Commission appointed to examine the Government's proposal to issue decrees suppressing import quotas was unable to approve of it because, in present circumstances, it would have involved the raising of import duties to a prohibitive level. The total value of imports during the past year was 20,945 million francs and of exports 15,472 million francs. The only increases of any kind were in the export tonnages of " material necessary for industry " and produce, and in the case of the former group there was an increase of 1,131,770 tons and a decline in value of 905 million francs. Valued at 3533 million francs, the imports of manufactured goods fell by 708 million francs, and exports of manufactured goods totalled 8745 million francs, a decline of 1360 million francs.

Loss of Giant Seaplane.

The foundering of the seaplane " Lieutenant-de-Vaisseau-Paris " in a harbour in Florida while on its long journey to the Antilles and back was an unfortunate ending to a great experiment which had until then proceeded satisfactorily and gave promise of success. A matter for congratulation is that when the seaplane was overturned and sunk by a cyclone there was no one on board. On being raised the machine will be dismantled and sent to France. The building of the " Lieutenant-de-Vaisseau-Paris " was started in 1931 at a time when there was still much discussion amongst experts concerning the practicability of the seaplane for ocean passenger traffic, the main objection being the taking-off with full load and the supposed danger of descending on other than fairly calm seas. The problem had to be solved for the South American air service, and three years were occupied in the construction of the machine, which weighed 37 tons without load, After undergoing successful trials the seaplane made its first public appearance at Havre on the occasion of the departure of the " Normandie " on her maiden voyage. It was a manifestation of big achievements on water and in the air. An accident to the seaplane when taking off at Havre to return to her base resulted in damage to one of the wings through collision with some fishing smacks. Recently the " Lieutenant-de-Vaisseau-Paris " started on its voyage to Dakar, across the South Atlantic to Brazil, and then to the Antilles, to take part in the tricentenary celebrations of those islands as a French colony, and it was to have returned by the same route before being put into regular passenger service between Dakar and the Brazilian port of Natal. Next summer the seaplane was to have crossed the North Atlantic. These projects are now indefinitely postponed.

Paris Well Boring.

The supply of water for the Paris area has reached a maximum until such time as the Vals de Loire scheme brings sufficient water to meet all needs for another fifty years or more, but as the work is likely to occupy many years the municipality is prudently investigating the possibility of utilising supplies believed to exist below the green clay forming the bed of the existing artesian well supply. A technical committee has been appointed for the purpose, with a credit of five million francs, to enable it to carry out experimental work. Existing wells to depths of between 1000ft. and 2000ft. already furnish a large volume of warm water, which is used principally for swimming baths and other public services, and in one suburb the water is cooled for distribution. Older artesian wells have either ceased supplying or the volumes delivered have declined. It is proposed to carry the new bore down to 10,000ft. if necessary.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

439,482. August 29th, 1935.—HEATING ELEMENTS FOR MERCURY BOILERS, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.*

Instead of using plain, round tubes as the heating elements of a mercury boiler, the inventors use a special form of rolled

Nº 439,482

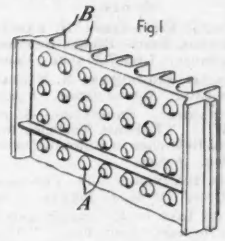


Fig. 1

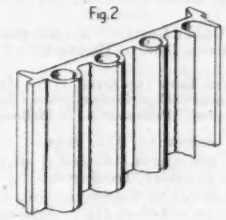


Fig. 2

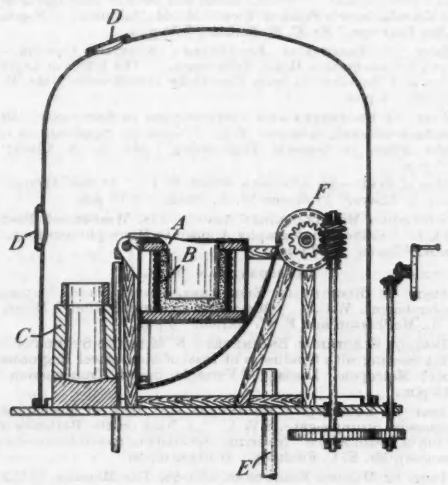
slab. This slab is rolled to the section shown in Fig. 1. The knobs A are for holding a refractory lining. The fins B are bent over, as shown in Fig. 2, and their edges welded together to form passages for the mercury.—*December 6th*, 1935.

FURNACES.

439,472. June 29th, 1935.—CORELESS INDUCTION FURNACES, *J. T. Shelvin, 15, South-street, London, E.C.2.*

It is sometimes required to melt metals in an induction furnace under vacuum or in a special atmosphere. It is then necessary to cover the furnace with a hood, which is preferably made of iron for economy and strength. It is claimed that no appreciable current will be induced in the hood if the distance from

Nº 439,472



the furnace coil to the hood is everywhere equal to the diameter of the coil. The drawing shows the tilting melting pot A with the induction coil B and a chill mould C. The hood has windows at D D and is evacuated through the connection E. The furnace is tilted by the gear F. In order to prevent disruptive discharges between the coil and the tilting frame the latter is insulated from earth.—*December 6th*, 1935.

BATTERIES AND ACCUMULATORS.

439,822. June 15th, 1934.—THE MANUFACTURE OF STORAGE BATTERY PLATES, Yoshihiko Tachihara, 1 of No. 699, Otamayamaye-sagaru Higashiiru Sokokujimonzen-cho, Karasumaru-dori, Kamikyo-ku, Kyoto, Japan.

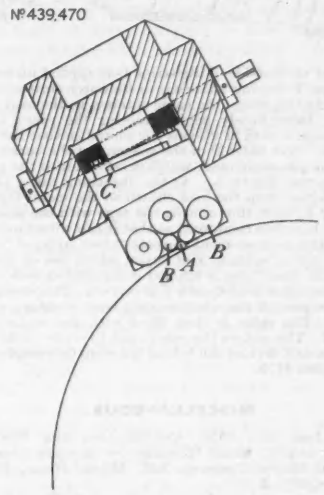
According to this invention, in the manufacture of storage battery plates, a grid filled with a paste of litharge, or lead oxides consisting mainly of litharge, is immersed in persulphuric acid or a persulphate solution as a step separate from the forming step. The persulphuric acid or the persulphate solution does not form the electrolyte of the storage battery. Thus, in carrying the invention into effect, a powder consisting of litharge, or mainly of litharge, is kneaded with dilute sulphuric acid or water by the ordinary process. Then the paste thus formed is filled in a grid and is subjected to the action of a solution of persulphuric acid or persulphate before or as an intermediate stage in the forming step and as an auxiliary operation to the forming step, so that it may be consolidated by oxidation. In this way it is possible to reduce the time required for the forming operation to about a fourth and produce a storage battery having great electric capacity and durability. The following are examples of carrying this invention into practice:—Knead the light and fluffy impalpable fine powder of litharge with dilute sulphuric acid of the specific gravity 1·05 or water, and fill it in the grid. Next, immerse it in 2 per cent. solution of persulphuric acid for three hours. After drying it or otherwise, immerse it in dilute sulphuric acid and subject it to the forming step by the ordinary process. Then the anode will be formed. In the preceding example, knead litharge or lead oxides consisting mainly of litharge with dilute sulphuric acid and fill the paste thus formed in the grid. After drying the paste, subject it to a forming step and take it out before the completion of the formation. Next, immerse it in 2 per cent. solution of ammonium persulphate for three hours, and then immerse it again in the forming bath, and continue the formation. Then the anode will be formed.—*December 16th*, 1935.

MACHINE TOOLS AND SHOP APPLIANCES.

439,470. June 20th, 1935.—REMOVING CRACKS IN THE SHELLS OF ROLLS, C. W. Hazelett, Rocky River, Ohio, U.S.A.

The longitudinal cracks which are formed in the surface of rolling mill rolls by the violent fluctuations in temperature

Nº 439,470

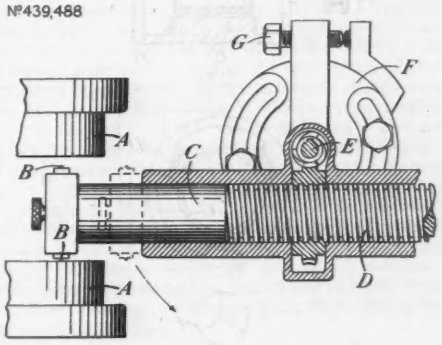


experienced during operation are removed, or rather closed, by the application of a small roll under high pressure. This roll is shown at A and is backed up by other rolls B B. The wedge C serves to press the burnishing roll on to the main roll.—*December 6th*, 1935.

439,488. May 8th, 1934.—TRUING GEAR FOR LAPPING MACHINES, The Newall Engineering Company, Ltd., and K. E. Summers, Old Fletton, Peterborough.

The lapping discs A A are trued up as occasion requires by the diamond tools B B. These tools are held by the stem C,

Nº 439,488



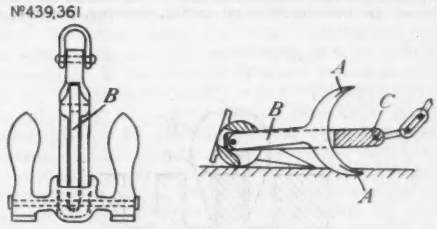
which can be fed forward by the screw D and worm gear E driven off the main shaft of the machine. When the tool is retracted to the position shown by the broken lines it can be swung clear on the sector plate F. The screw stop G serves for setting purposes.—*December 9th*, 1935.

SHIPS AND BOATS.

439,361. June 5th, 1934.—STOCKLESS ANCHORS, N. E. Lundin, Mölle, Malmöhus, Sweden.

This anchor is of the stockless type and has auxiliary flukes

Nº 439,361



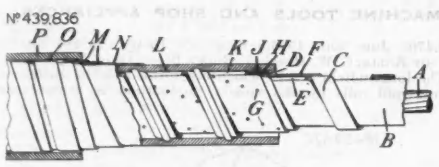
A A on a stem B, which is pivoted in a bifurcation of the main stock C. It is said to be considerably lighter than the usual type of " patent " anchor.—*December 5th*, 1935.

TRANSMISSION OF POWER.

439,836. June 20th, 1934.—ELECTRIC CABLES, W.T. Henley's Telegraph Works Company, Ltd., 11, Holborn-viaduct, London, E.C.1, and P. Dunsheath, " Hesket," Church-avenue, Sidcup, Kent.

The conductor A is built up of sector-shaped wires round a central, circular wire so as to produce a conductor without any substantial spaces between wires along which the impregnat-

ing material could travel freely. This conductor is covered with the paper dielectric B in the usual way and this is impregnated. The outer layer of the dielectric is provided with a conductive covering in the usual way to serve as an equipotential surface and screen. On the outside of the conductive covering of the dielectric is applied the helical spacing strip, which consists of an inner part C and an outer part D, each consisting of several layers of metallised paper strip. The inner part C is applied as an open spiral so as to leave a wide space E between the turns. On the outside of this inner part C is applied a wide strip of metallised paper F. This strip (hereinafter referred to as "the barrier strip") bridges the space E and rests at each side on adjacent turns of the part C of the spacer. The strip F has a suitable number of small perforations G of such a size that viscous compound will not flow freely through them. The metallised paper strips D, forming the outer part of the spacer, are then applied over the inner part C, and the edges of the strip F so as to hold the barrier strip in

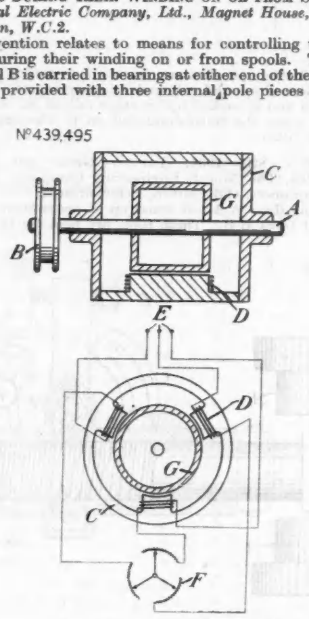


place. Over the outside of the strips D is applied under tension a metal tape H having adhering to its outer surface a strip J of solder. At this stage, the cable is taken to the lead press for sheathing. Immediately before entering the press, the cable passes through a bath of viscous compound so that the space K between the outer parts D of the spacer and the barrier strip F is filled with this compound, which is carried into the press and enclosed by the sheath L. As the sheathing takes place, the heat transferred from the lead sheath to the metal tape causes the solder J to melt, thus uniting the tape with the lead sheath. The sheath L is then reinforced so that it can withstand internal pressure. The reinforcement consists of two layers of brass tape M applied over a bedding N of paper, which lies on the sheath L. Over the brass tape is applied compounded cotton tape O and then the outer lead sheath P is put on. This sheath serves primarily to protect the reinforcement from moisture and other influences. The cable is then filled with gas under pressure and heated. This causes the compound to settle to the bottom of the cable, and divides the helical space up into single turns.—*December 16th*, 1935.

MISCELLANEOUS.

439,495. June 5th, 1934.—CONTROLLING THE TENSION OF WIRES DURING THEIR WINDING ON OR FROM SPOOLS, *The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2.*

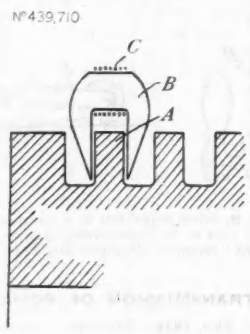
This invention relates to means for controlling the tension of wires during their winding on or from spools. The axis A of the spool B is carried in bearings at either end of the cylindrical housing C provided with three internal pole pieces D carrying



a coil star-connected across a three-phase supply E. Regulating resistances F are inserted in the circuit. The housing and the pole pieces form the stator of the motor. The rotor is a hollow iron cylinder G mounted on the axis A within the stator; it will be driven by the supply in the well-known manner. But since the motor is not synchronous, the rotor can slip and yield elastically to varying tension on the wire. It can thus regulate the tension in the same way as the known induction brakes and clutches.—*December 5th*, 1935.

439,710. September 27th, 1934.—RECORDING ACOUSTIC VIBRATIONS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

According to this invention, plates or cylinders for recording purposes are manufactured by casting, spraying, pressing, or



in a similar manner, from a fine iron powder and a non-magnetic embedding material which is plastic at low temperatures. As the magnetic pulverulent material the known iron powder derived from iron carbonyl, which is used for the manufacture of the cores of Pupin coils, is found particularly suitable. Styrol, with the addition of a thinning medium, has given excellent results for the embedding material. These two materials are well mixed together, in some cases with the addition of a further filling material, and are then brought into the desired form by pressing, this form being a circular plate with a continuous spiral, A, for example. A plate of this kind may be manufactured with a thickness of approximately 2 mm., the impressed spiral being about ½ mm. deep. The groove is ½ mm. wide and serves to guide the magnetic pick-up head B, which has a winding C. The records are said to have a remarkably long life.—*December 12th*, 1935.

Forthcoming Engagements.*

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN CENTRE.—Grand Assembly Rooms, Barras Bridge, Newcastle-upon-Tyne. Annual dinner and dance. 7 for 7.30 p.m. Cancelled.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND CENTRE.—Grand Hotel, Harrogate. Annual dance. 8 p.m. to 2 a.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. "Exhaust Turbines for Marine Propulsion, with Special Reference to Rowan-Götaverken System," Dr. J. B. O. Sneeden. 6 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Gears and their Uses," Dr. H. E. Merritt. 7.30 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—At Mining Inst., Newcastle-upon-Tyne. "The Protection of Ships' Hulls Against Marine Corrosion," Mr. William E. Lewis. 6 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse, "Sensitising Dyes in Photography," Dr. C. E. K. Mees. 9 p.m.

WEST OF SCOTLAND IRON AND STEEL INST.—In the Societies' Room, Royal Technical College, George-street, Glasgow. "High-pressure Steam Boilers," Professor A. L. Mellanby. 7.15 p.m.

SATURDAY, JAN. 25TH.

INST. OF CIVIL ENGINEERS.—Students' afternoon visit to National Physical Laboratory, Teddington.

N. EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS: GRADUATES' SECTION.—Bolbec Hall, Newcastle-upon-Tyne. "The Design of Cargo Ships," Mr. R. Lowery. 7.15 p.m.

MONDAY, JAN. 27TH.

BRADFORD ENGINEERING SOC.—At Technical College, Bradford. "Arc Welding as Applied to Structural Engineering," Mr. R. J. Fowler. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: NORTH-EASTERN CENTRE.—At the Rendezvous Restaurant, Pilgrim-street, Newcastle-on-Tyne. "Radio Interference from Electrical Power Circuits," Messrs. W. F. Smith and P. J. Ryle. 7 p.m.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND CENTRE.—James Watt Memorial Inst., Great Charles-street, Birmingham. An informal discussion on "Domestic Electric Appliances," opened by Messrs. C. S. Cattell and G. E. Middleton. 7 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Graduates' Section. "Fluid Joints," Mr. V. A. Yardley. 6.45 p.m.

TUESDAY, JAN. 28TH.

INST. OF AUTOMOBILE ENGINEERS.—James Watt Memorial Inst., Birmingham. "White Metal and Bronze Bearings from the Manufacturer's Point of View," Mr. M. Melhuish; "Needle Roller Bearings," Mr. C. H. Smith. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—North British Station Hotel, Edinburgh. "The Effect of Legislation and Regulations upon Electricity Distribution," Mr. W. Fennell. 7 p.m.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Notes on Applications of Light Alloys to General Engineering," Mr. G. A. Clavey. 7.30 p.m.

ROYAL INST.—21, Albemarle-street, W.1. "Atomic Arrangement in Alloys," Professor W. L. Bragg. 5.15 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. "Colour Photography Applied to Micro-photography," Mr. A. Allison. 7.30 p.m.

THURSDAY, JAN. 30TH.

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C.2. "Micro-Ray Communication," Messrs. W. L. McPherson and E. H. Ullrich. 6 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Joint meeting with Graduates of Inst. of Mechanical Engineers. Hotel Metropole, Leeds. "Variable Speed Transmission." 7.15 p.m.

INST. OF LOCOMOTIVE ENGINEERS.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "A Note on the Railways of Union of South Africa" (referring especially to recent locomotive practice), Mr. E. C. Poultney. 5.30 for 6 p.m.

INST. OF MARINE ENGINEERS.—85–88, The Minories, E.C.3. "The History of Technical Education," Principal J. Paley Yorke. 6 p.m.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—James Watt Memorial Inst., Birmingham. "The Polishing of Metals," Mr. E. J. Dobbs. 7 p.m.

INST. OF MINING ENGINEERS.—At Geological Soc., Burlington House, W.1. Annual general meeting. Discussion, "Interim Report of the Joint Committee on the Cause, Prevention, and Methods of Dealing with Underground Fires." 11.15 a.m. Discussions: (*a*) "Coal for Mechanical Stokers," Mr. H. L. Pirie; (*b*) "The Effect of Height of Roof and of Tubs upon the Energy Output of the Miner when Loading," Professor K. Neville Moss. 2.15 p.m. At Grosvenor House, Park-lane, W.1. Annual dinner. 7.15 for 7.45 p.m.

INST. OF STRUCTURAL ENGINEERS: YORKSHIRE BRANCH.—Hotel Metropole, Leeds. "Underpinning and Foundation Work in Loose and Waterlogged Ground by Chemical Consolidation, Ground Water Lowering, and other Means," Mr. H. J. B. Harding. 7 p.m.

ROYAL INST.—21, Albemarle-street, W.1. "Leonardo da Vinci," Mr. Kenneth Clark. 5.15 p.m.

FRIDAY, JAN. 31ST.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Internal Combustion Engine Group. Informal discussion, introduced by Mr. E. C. Ottaway, on "Service Maintenance of High-speed Internal Combustion Engines for Transport and Power." 7 p.m.

* Probably most of the Social Engagements will be cancelled.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Machinery and Engineering in Ancient Times," Mr. R. P. Howgrave-Graham. 7.30 p.m.

WEDNESDAY, FEB. 5TH.

INST. OF CIVIL ENGINEERS: MANCHESTER AND DISTRICT ASSOC.—Midland Hotel, Manchester. Annual dinner. 6.30 for 7 p.m.

THURSDAY, FEB. 6TH.

BIRMINGHAM UNIVERSITY ENGINEERING SOC.—At the University, Edgbaston. Lecture, "Some Aspects on Industrial Installation Work." 5.45 p.m.

FRIDAY, FEB. 7TH.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Education Group. Mr. F. E. Robinson will introduce discussion on "The Training of Craftsman." 6 p.m.

INST. OF SANITARY ENGINEERS.—Caxton Hall, Westminster, S.W.1. "Difficulties Encountered Owing to the Presence of Water in Sewerage Workings," Mr. H. C. H. Shenton. 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Early Windmill Gearing," Mr. Reginald Wailes. 7.30 p.m.

THURSDAY, FEB. 13TH.

INST. OF AUTOMOBILE ENGINEERS.—At Merchant Venturers' Technical College, Bristol. "The Development Testing of Motor Cars," Mr. C. M. Simpson. 7 p.m.

FRIDAY, FEB. 14TH.

CHEMICAL ENGINEERING GROUP.—At the Rooms of the Chemical Soc., Burlington House, Piccadilly, W.1. "Some Aspects of Chemical Works Pumping and Acid Handling," Mr. E. A. Reavell. 8 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Informal meeting. "The Mechanics of Gliding," Mr. Robert Kronfeld. 7 p.m.

THURSDAY, FEB. 20TH.

RAILWAY CLUB.—At Royal Scottish Corporation Hall, Fetter-lane, E.C.4. Annual general meeting. Presidential address, "British Railways in 1845," Mr. Kenneth Brown. 7.30 p.m.

WEDNESDAY, MARCH 18TH.

INST. OF AUTOMOBILE ENGINEERS.—At Metropole Hotel, Leeds. "The Development Testing of Motor Cars," Mr. C. M. Simpson. 7.15 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

STEAM PLANT ACCESSORIES, Ltd., of 59, Palace-street, Victoria-street, S.W.1, is removing to more extensive offices at 82, Victoria-street, S.W.1.

GEORGE H. ALEXANDER MACHINERY, Ltd., Birmingham, 4, has been appointed the sole agent for the patentees and designers of the hydraulic duplicator. The principals, Messrs. Curtis L. Walker and Edmund J. Wall, are now trading under the title of the Hydraulic Duplicator Company, of Detroit.

MR. ALFRED G. JEFFS, who has been chairman of Henry Meadows, Ltd., Wolverhampton, since the company's inception in 1919, has reluctantly resigned from the board for reasons of ill-health. Mr. Henry Meadows, who founded the firm and has been managing director from the commencement, has been unanimously elected chairman in his stead.

BABCOCK AND WILCOX, Ltd., inform us that, as from February 29th, their Sheffield office will be closed down and transferred to Gresham House, 7, St. Paul's-street, Leeds. Mr. A. Pigott, former manager of the Sheffield office, has now retired, and Mr. E. N. Taylor has been appointed district manager in his stead, with his office at Leeds, on and after March 2nd.

CATALOGUES.

REVVO CASTOR COMPANY, Ltd., Blechynden-street, London, W.11.—Castor list No. 6.

HERBERT MORRIS, Ltd., Loughborough.—Book 190 on pulley blocks and other lifting gear.

T. C. JONES AND CO., Ltd., 93–95, Wood-lane, W.12.—Catalogue No. A 4 of 336-page book of engineering equipment of all kinds.

BRITISH INSULATED CABLES, Ltd., Prescot, Lancs.—A number of leaflets and two booklets on jointing materials, and the B.I./Mackintosh "under the eaves" distribution system.

THE FAIRFIELD S. AND E. COMPANY, Ltd., Chepstow, Mon.—A book illustrating the firm's products entitled "Bridge and Constructional Engineering and Railway Wagon Building."

FIRTH-VICKERS STAINLESS STEELS, Ltd., Staybrite Works, Sheffield, 9.—A publication giving concise information on the various forms in which stainless and "Staybrite" steels are supplied.

ASSOCIATED EQUIPMENT COMPANY, Ltd., Southall, Middlesex.—A set of the company's latest literature on its products, which include buses, coaches, commercial vehicles, railcars, and marine and industrial units.

J. BROWETT LINDLEY (1931), Ltd., Letchworth, Herts.—Publication No. B 127, dealing with the use of heating and process steam for power purposes by means of the firm's back-pressure and extraction steam engines.

RICHARDSONS, WESTGARTH AND CO., Ltd., Hartlepool.—A brochure describing the "Deptford" rotary water strainer, which is intended for removing major impurities from circulating water before it passes into condensing plant.

RUSTON AND HORNSBY, Ltd., Lincoln.—A copy of a publication entitled "Appreciation," containing photographs showing Ruston locomotives at work and testimonials from quarry owners, sand and gravel merchants, public works contractors, and other users of these machines.

KLIP POWER STATION, S.A.—Excellent progress is being made with the erection and equipment of the Klip electricity generating station—situated about 6 miles from Vereeniging and in the Meyerton district of the Transvaal—which for the present will have six turbo-generators of 33,000 kW each installed and twelve boilers. The equipment will include six cooling towers, each capable of dealing with 2,000,000 gallons of water per hour, and three are already completed. They are each 220ft. high and contain 200 miles of special timber and 350 tons of steel reinforcement. They are the first of their kind in South Africa. The water required for cooling purposes will be brought 5½ miles from the Vaal River through an 18in. diameter pipe line. The initial installation of six turbo-alternators will require 1,850,000 lb. of steam per hour, and for condensing purposes the circulation of 9,000,000 gallons of water per hour will be required. The steam pressure will be 345 lb. per square inch at a temperature of 734 deg. Fah.

A Seven-Day Journal

New Oxygen Developments.

POWERS for the formation of a company to be called the Caledonian Power Company are being sought by the British Oxygen Company. The new firm is to supply electricity mainly to an electro-chemical undertaking to be established near Fort William by the British Oxygen Company. The capital proposed is £500,000, with powers to increase the amount to an extent authorised by the Electricity Commissioners. The compulsory powers to take land sought by the company may be exercised when £100,000 of the capital has been subscribed. It will be several years before the works involved in the undertaking are completed. The directors of the new company are all members of the board of the British Oxygen Company. They include Dr. J. D. Pollock (chairman, British Oxygen Company), Mr. S. J. L. Hardie, Mr. R. W. McCrone, Mr. C. Sharp, Mr. P. B. Liversidge, Mr. C. Dunbar, and Mr. E. W. Sprott. Another recent undertaking in which the British Oxygen Company is interested is styled Industrial Gases. It has been formed with the co-operation of the British Oxygen Company and Hammond Lane Foundry, which firm has the preponderating interest, for the purpose of establishing the oxygen industry in the Irish Free State.

New Naval Vessels Launched.

ON Thursday, January 23rd, there was launched from the Vickers-Armstrongs Naval Yard at High Walker, the first of the "Southampton" class cruisers H.M.S. "Newcastle," which was named by the Duchess of Northumberland. The new 9000-ton displacement ship, which has a water-line length of about 584ft., and a beam of 61ft. 8in., will be equipped with turbine machinery of about 96,000 s.h.p., designed for a speed of 32 knots. She will carry her 6in. guns in triple turrets, and will have, besides, an anti-aircraft armament of eight 4in. guns. Twenty-two smaller guns and eight torpedo tubes are to be mounted. Other equipment includes two aircraft and a catapult. H.M.S. "Newcastle" was laid down on October 4th, 1934, and will be delivered in January, 1937. A sister ship, H.M.S. "Sheffield," is being built on the berth adjoining that vacated by the "Newcastle." The machinery for these two vessels is being made at the Barrow Works of Vickers-Armstrongs, Ltd. There are also building at the Naval Yard two destroyers, H.M.S. "Hero" and H.M.S. "Hereward." The construction of these four vessels for H.M. Navy is providing employment for a large number of men in a distressed area. On Wednesday, January 22nd, the launch of the sloop H.M.S. "Aberdeen" took place at Devonport Dockyard.

The Chamber of Shipping.

AT a meeting of the Council of the Chamber of Shipping held on Thursday, January 23rd, Sir F. Vernon Thomson was unanimously nominated as President for 1936–37 on the motion of Sir William Currie, seconded by Mr. G. Leighton Seager, the Vice-President. On the motion of Mr. Philip Runciman, seconded by Mr. R. I. Dodsworth, Sir Richard D. Holt was unanimously nominated Vice-President. These nominations will be submitted for election at the annual meeting on February 27th. Sir F. Vernon Thomson is a director of Dodd Thomson (1934), and the chairman of the King Line, Ltd., and of the London Maritime Investment Company. Ltd. He is deputy chairman and joint managing director of the Union-Castle Mail Steamship Company, Ltd., and is also on the boards of the London and Thames Haven Oil Wharves, Ltd., and of the British Motorship Company, Ltd. Sir Richard Holt, of Alfred Holt and Co., is chairman of the Mersey Docks and Harbour Board. He is a deputy chairman of Martins Bank and is chairman of Elder Dempster Lines, of the Glen Line, and of India Buildings, Liverpool, and a director of other shipping companies.

Coal Dispute Settlement.

ON Friday last, January 24th, a settlement of the coal miners' wages dispute, mentioned in a Journal note of January 10th, was arrived at. The amended offers made by the mineowners were accepted by a full delegate conference with a majority of 248,000 votes. The President of the Mine Workers' Federation announced at the close of the conference that with improved wage offers coupled with national recognition the Federation could not contemplate industrial disturbance at this period of national mourning. The turning point in the negotiations was reached when the proposal was made by the owners that a joint standing consultative committee should be set up to consider all questions of common interest and of general application to the industry, not excluding general principles applicable to the determination of wages by district agreements. The establishment of this committee will bring about a complete change in the relationships within the coal industry and should remove many of the causes of unrest. Such changes as are likely to occur in the near future, such as the possible establishment of central marketing schemes, will be greatly assisted by the advice of the new body on all matters which affect the men. The terms of reference of the committee are likely to be very wide and its scope will, in consequence, take in all matters upon which friction may arise. No limit has been set upon the agreements which will be concluded in the various districts, the present offers being accepted as an instalment of the further improvement which will be rendered possible by the proposed schemes.

The 1936 Empire Exhibition in South Africa.

AT a meeting of the British Empire League, held on Friday, January 24th, at the British Empire Club, London, under the chairmanship of Captain D. Euan Wallace, the Secretary of the Department of Overseas Trade, Lord Riverdale of Sheffield, spoke of the rapid development of South Africa and the opportunity now presented to British manufacturers to participate in the forthcoming Empire Exhibition, which will be opened in Johannesburg on September 15th, 1936. After enumerating many of the features of the Exhibition, Lord Riverdale said that, from a business point of view, he could thoroughly recommend it as offering an opportunity to show what British manufacturers could do and to examine the South African market with a view to the expansion of trade. The United Kingdom was, he said, the best customer of the Union and also her principal supplier, and there was nothing so sound as a two-way trade. As an export market for United Kingdom goods South Africa ranked second only to British India, and in 1934 took goods to the value of some £32,000,000. The imports into the Union for the first six months of 1935 showed an increase of £5,600,000, and of this total the United Kingdom supplied 49 per cent. In metals and manufactures, including machinery and vehicles, South Africa imported over £24,000,000 in 1934, but we had supplied only £12,000,000 in this item alone. If the market was studied and our goods shown in the right way there lay a large field for further expansion. The same might be said for the item of fibres, yarns, textiles, and apparel. In 1934 the Union's total imports for these were £15,500,000, of which the United Kingdom's share was under £10,000,000. Over 70 per cent. of the total space in the buildings originally laid out had been booked, and it was already clear that large extensions of the buildings would have to take place.

A Scottish Steel Merger.

DURING the last few years efforts have constantly been made towards a closer co-ordination of Scottish steel-producing interests. On Monday, January 27th, it was officially announced that Colvilles, Ltd., had acquired practically the whole share capital of the Steel Company of Scotland, Ltd., from the shareholders of that company. It is stated that the present board of the company, of which Sir James Lithgow is the chairman, will remain in office. It may be recalled that Colvilles, Ltd., which was formed in 1930, and whose chairman and managing director is Mr. John Craig, then acquired the steel works of David Colville and Sons, Ltd., and of James Dunlop and Co., Ltd. It has now also acquired from David Colville and Sons, Ltd., the whole ordinary share capital of Smith and McLean, Ltd., and the whole of the issued capital of the Clyde Alloy Steel Company, Ltd., the Fullwood Foundry Company, Ltd., and the Carnlough Lime Company, Ltd. In all cases the whole of the purchase price is being satisfied by the allotment of ordinary shares of Colvilles, Ltd., credited as fully paid. This amalgamation, in view of its important relations with Scottish shipbuilding firms and Harland and Wolff, Ltd., at Belfast, is one of the most important industrial groupings of recent years.

Employment in Engineering.

THE problem of the provision of skilled men in sufficient numbers to meet the requirements of the engineering industry has frequently been referred to in these columns. The Amalgamated Engineering Union has now issued a statement denying that the men are not available and places the responsibility for the apparent shortage partly on the employers and partly on the lack of housing accommodation in localities where the demand for skilled men is now arising. The Union complains that unemployed skilled men over forty-five years of age are not being offered work, while men who, on completion of their indentures, were unable to obtain work owing to the industrial depression are passed over. The Union would welcome a responsible inquiry into the question. It is confident that there would be no shortage of skilled labour if employers would give opportunities of working to unemployed craftsmen. Unfortunately, in practice, employers impose an age limit. There are many skilled craftsmen over forty-five years of age who cannot get employment because employers regard them as too old, or reject them as disqualified for skilled employment owing to long periods of unemployment. The same reason is advanced in the case of young men who served an apprenticeship in the industry, but were unable to find employment therein when their indentures expired. Employers tend to regard these young men as unfit for skilled work because they have not had employment since their apprenticeship expired. The wages offered to men who must maintain their families at a distance from their own place of employment are considered to be totally inadequate by the Union. Provision, they consider, should be made to allow men to remove their families to the areas where employment is available.

The E.R.A. Report.

THE fifteenth annual report of the British Electrical and Allied Industries Research Association refers to many important investigations carried out during 1935. At the close of the year the Association had a technical staff of fifty-one persons and an administrative and clerical staff of thirty-three. Attention is again drawn to the fact that there are still some contributors who benefit by the work done, but do not bear their full share of the cost. Expenditure on industrial research in other countries, it is explained, is on the up grade, and Great Britain can only hold her own in world competition if she keeps her research programmes in advance of those of her competitors. It is gratifying to note, however, that during the year twenty-seven additional manufacturers and thirty supply authorities, including some in the Dominions and Colonies, agreed to subscribe to the Association. Of the 623 reports now available, 82 were issued during the year, each representing on an average an expenditure of £700. Three booklets were also published by the Association with the respective titles: "Manufacturers Testify to the Value of Co-operative Research," "How Research Saves the Supply Industry 100 per Cent. More Than it Costs," and "How Research Reduces a Supply Undertaking's Capital Outlay, Working Expenses, and Maintenance Charges." Close and active co-operation was maintained with the I.E.E., the British Standards Institution, the N.P.L., the G.P.O., B.B.C., and many other bodies. The Association nominated representatives on about fifty committees of these bodies, and, where necessary, furnished special information and carried out research for them.

New G.W.R. Directors.

ON Friday, January 24th, it was announced that the Earl of Dudley and Colonel Sir W. Charles Wright had been elected directors of the Great Western Railway Company. Lord Dudley, it may be recalled, has extensive interests in the iron and steel and coal industries. He is President of the British Iron and Steel Federation, and a director of the British Iron and Steel Corporation, which was formed to implement the cartel agreement. He is also chairman of the Earl of Dudley's Round Oak Works and of the Earl of Dudley's Baggeridge Colliery; while Sir Charles Wright is chairman of Baldwins Ltd., British Mannesmann Tube Company, Ltd., Fairwood Tinplate Company, Ltd., the Midland Employers' Mutual Assurance, and deputy chairman and managing director of the British (Guest Keen Baldwins) Iron and Steel Company, Ltd. He is also on the boards of a number of other important companies, including the Shell Transport and Trading Company, Ltd., and Venezuelan Oil Concessions, Ltd.

David Brown's Penistone Works.

IN one of our Journal notes of last week we referred to the reopening of the former Cammell, Laird works at Penistone, which have been acquired by David Brown and Sons (Huddersfield), Ltd. The official opening of the works took place on Friday, January 24th, when the first casting was made in the new iron-foundry. We are in a position to state officially that the Penistone works have been acquired in order to provide much-needed room for the expansion of the firm's Huddersfield works, which were founded thirty-four years ago, and are now as large as the site will allow. The new site at Penistone includes not only the former Cammell, Laird steel works, but an adjacent 30-acre site. It is intended to transfer to this new site all the company's foundry and forge departments, and in doing so make each of these departments thoroughly up to date in lay-out, equipment, and methods. Since many new processes are being adopted and much special equipment is needed, the building up of output at the Penistone works and the transfer of the corresponding departments from the Huddersfield works will necessarily take some time, and the plant and output available now represents only a very small fraction of what will be available in six or twelve months' time. It is hoped that in time a large proportion of local labour will be employed, and training, for the special processes, will take place gradually. Great attention is being paid to lighting, heating, and ventilation to secure the maximum comfort of the workers. David Brown and Sons (Huddersfield), Ltd., also controls P. R. Jackson and Co., Ltd., the steel founders and gearing makers, of Manchester, and the Keighley Gear Company.

American Beach and Shore Protection Works.

By E. E. R. TRATMAN.

No. III.

(*Continued from page 94, January 24th.*)

EXAMPLES may be given briefly of both the concrete and the steel vertical braced sea walls just mentioned.

Virginia Beach Sea Wall.

A good example of a thin vertical sea wall of concrete construction is that at Virginia Beach, a resort on the southern part of the Atlantic coast. Built in 1926–27, it has withstood successfully a number of severe storms. In a violent storm from the north-east in August, 1933, combined with an exceptionally high tide, the waves swept entirely over the wall and promenade, but without injury to the concrete structure. An old wreck carried by the waves carried away part of the iron hand railing.

An interesting point of this structure is the change in design from precast members to monolithic concrete during construction. The sea wall as built is shown in Fig. 18. In the original design the wall was to consist of large square concrete piles, 17in. by 22in., 14ft. apart, having the sides grooved to receive precast concrete slabs or planks, 8in. thick and 27in. deep, with horizontal tongue and groove joints between the planks. A continuous coping was to be cast in place along the top planks. Precast concrete transverse girders, 12in. by 20in., were to be seated on the concrete piles and on a rear row of timber piles. A concrete walk or promenade was to be poured in place, carried by the girders.

While this general design was followed, the precast planks were replaced by concrete panels poured in place and monolithic with the coping and the transverse girders. The face panels were carried to a depth of 9ft. or 10ft., instead of 6½ft., as planned for the plank design. A 2in. weep hole, just above the beach surface, was formed in each 14ft. panel. To tie the structure together and anchor the wall in place, the rear end of each transverse girder is notched to fit into a circular concrete cap or block, 36in. by 24in. and 18in. thick, cast on the head of the anchor pile. These piles of creosoted timber are 30ft. long.

The 5in. reinforced concrete slab of the promenade is supported only by the transverse girders, of which it forms an integral part, although sand filling was pumped behind the wall to the level of the tops of the girders. This slab, 20ft. wide, has a small curb along the landward side, and cored holes along the seaward side to receive the concrete lamp posts and the stanchions for the hand railing. Transverse expansion joints are formed at intervals of 70ft., or five spans.

Opposite the streets leading to the beach are concrete stairways, 8½ft. wide. They are monolithic structures, having side beams which are supported at the top by the longitudinal beam or coping of the sea wall, and at the foot by a pair of 30ft. timber piles. The steps have 10in. treads and 8in. risers, with the bottom step formed as a heavy cross girder seated on the piles. Iron pipe railings are set in the beams.

A doubt as to the efficiency of a structure composed of independent members in resisting the attacks of heavy storm waves was the reason for the change to monolithic concrete construction. While this sea wall has proved satisfactory and successful, the builder, Mr. F. A. Haycox, considered that for resisting such wave attacks a vertical sea wall is inferior to a sloping wall on which the waves may expend their energy. This reasoning he applies from the standpoint of appearance, as well as from the practical and economic standpoints.

Steel Sea Wall at Cape May.

A recent example of steel sheet pile braced construction for sea walls is that at the city of Cape May, on the Atlantic coast, replacing an old timber structure. This wall, shown in Fig. 19, consists of interlocking steel piles of rather deep trough section, capped by a 13in. rolled steel channel bolted along the top, which is about 18ft. above sea level. At this place there is no appreciable amount of beach along the seaward side of the wall, except at extreme low tide. At high tide, and especially during storms from the north-east, the wall has to sustain the impact of very heavy seas. Unlike some other sea walls of steel sheet piling, the wall at Cape May has no inclined coping or wave break to throw back the crests of waves that break against the wall. Nor has it any rockwork in front to break up the waves.

At some distance behind the wall proper are creosoted timber anchor piles, in pairs spaced about 10ft. apart. Those of each pair have an 8in. by 8in. creosoted block, 2ft. high, bolted between them, while on the seaward side is a short horizontal timber, 6in. by 8in., and on the rear is a short piece of 10in. rolled steel channel. These anchor piles are 16ft. long with their tops 8ft. above sea level or about 7ft. above the original ground surface.

From each anchorage a 1¼in. tie-rod extends to and through the steel sheeting, its outer end passing between a pair of 10in. rolled steel channels, which form a waling piece along the face of the wall. Beneath the tie-rod is a 6in. by 8in. timber strut, butted against the steel sheeting, where it rests on an angle bracket. Its rear end is butted against the cross timber on the anchor piles, or against an existing line of timber sheeting, which is retained in the new work. Longitudinal timbers of the same size are fitted between the transverse struts.

Sand is filled in behind the steel sheeting to within about 2ft. from the top, and this is covered with gravel to prevent winds from disturbing the sand filling. Where street drains have to be extended to the sea, each drain ends in a scupper box of creosoted timber built against the seaward face of the old timber sheeting, as shown. From this box a 12in. cast iron pipe extends to and through the steel sheet piling, an 18in. hole being cut for the purpose. A steel sleeve surrounds the end of the pipe as a protection and support, and concrete is filled around this to form a thimble supporting the pipe and sleeve and sealing the hole in the sheeting.

Beach Groins.

Groins built across the beach and extending beyond the water line are frequently used as a means of beach protection. They are sometimes called jetties, but the two words are not properly synonymous or interchangeable in marine engineering. These groins may serve different purposes—to break the sweep of the waves, to stop erosion by waves and currents, to check the drift of sand along the beach above the high water line, and to maintain or build up the beach. Their efficiency depends upon their adaptation to the local conditions, and these vary at almost every beach or location. Thus no type of construction and no length or spacing of the groins can be specified for universal application. However, they are usually at approximately right angles to the line of the shore, and a rather general rule is that the distance between the groins should not exceed three times their length.

In a report of the United States Beach Erosion Board, it is considered that there is no necessity of making groins higher than the uprush of the water at high tide, and that high groins usually result in marked erosion of the leeward beach. The Board favoured a crest horizontal at the shore end and then sloping down at slightly less than the slope of the foreshore until it reached about mid-tide level, beyond which point the crest would again be horizontal. This conforms to the general opinion that with part of the crest of a groin below high tide level the sand in suspension will be carried over with the water, so that the beach will build up to a fairly uniform level. Groins may be used alone or in conjunction with sea walls or bulkheads, according to conditions. Under certain special circumstances they may not be permissible, as on some parts of the Florida coast, where the firm and smooth flat sand beach is a favourite place for automobile riding and racing.

Groin Design.—One of the most general types of construction for beach groins consists of plank sheeting—with interlocking joints in modern practice—stiffened by waling pieces and strengthened by round piles at intervals along both sides of the sheeting. Interlocking steel and concrete sheet piling have also been used, and corrosion of the steel seems to be slight as a rule. Sometimes a ridge of quarry rock is deposited along the top of the sheeting. In any case, it is important to drive the sheeting deep enough for a firm hold, and to prevent undermining or scour by the waves and undertow. A more substantial construction, though rather detracting from the appearance of the beach, consists of two rows of piling connected by tie-rods and struts, with heavy rock filling between the two rows. Some forms of groin construction are described in other parts of this article.

Rock Groins.—Effective protection of a bathing beach at Provincetown, behind which is a public road, is provided by rock or stone groins, 150ft. long and 400ft. apart. These groins, Fig. 20, about 5ft. high, 5ft. wide on top and 20ft. on the bottom, are composed of a core of broken stone and

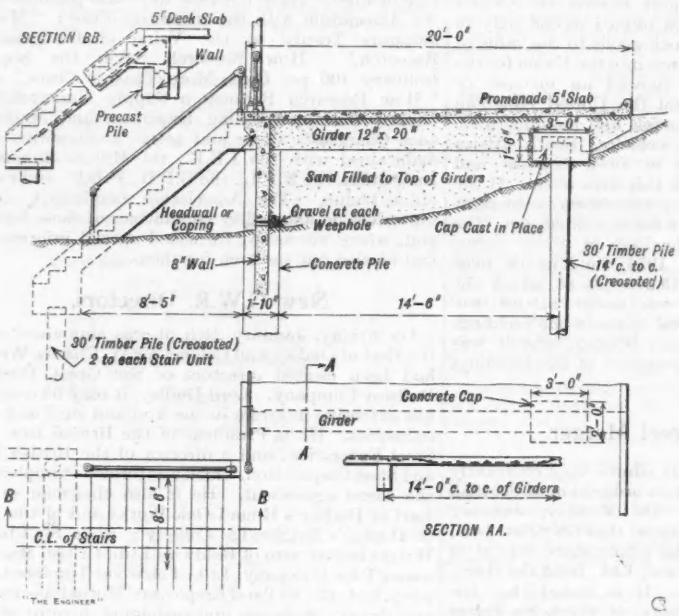


FIG. 18—VIRGINIA BEACH SEA WALL

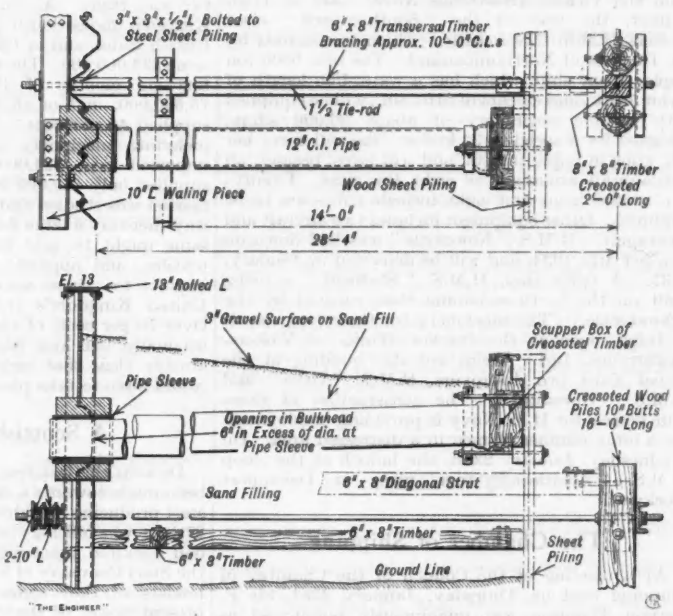

3" x 3" x ½" L Bolted to Steel Sheet Piling
6" x 8" Transversal Timber Bracing Approx. 10'-0" C.L.s
1½" Tie-rod
12" C.I. Pipe
Wood Sheet Piling
8" x 8" Timber Creosoted 2'-0" Long
10" L Waling Piece
14'-0"
28'-4"
El. 13
13" Rolled C
3" Gravel Surface on Sand Fill
Scupper Box of Creosoted Timber
Pipe Sleeve
Creosoted Wood Piles 10" Butts 16'-0" Long
Opening in Bulkhead 6" in Excess of dia. at Pipe Sleeve
Sand Filling
6" x 8" Diagonal Strut
6" x 8" Timber
2-10" L
6" x 8" Timber
Ground Line
Sheet Piling
"The Engineer"

FIG. 19—STEEL SEA WALL AT CAPE MAY

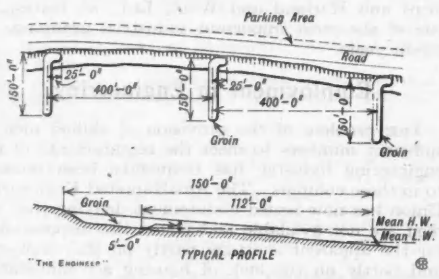


FIG. 20—GROINS AT PROVINCETOWN

a covering of large quarry blocks to protect the smaller rock from the attacks of the waves. An unusual feature is that each groin has at its shore end a short right-angle extension parallel with the higher ground behind the beach.

This beach protection is an example of much work done by the Massachusetts State Department of Public Works. The rough rock construction is considered preferable to timber, concrete, or steel sheet piling, all of which have been used to some extent. It is found that the waves ride along the comparatively smooth faces of these latter groins with little breaking up. But waves that strike the rough and irregular surfaces of the rock groins have their force largely reduced by breaking against the projections and by the eddies resulting from the passage of water

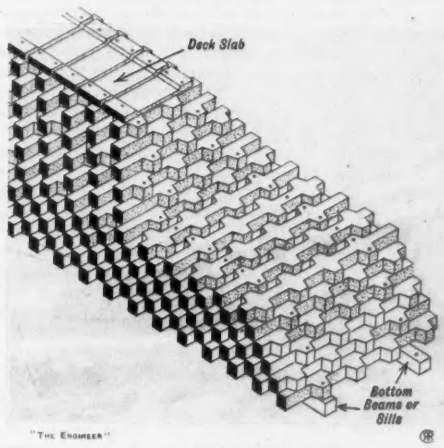


FIG. 21—PRE-CAST CONCRETE PERMEABLE GROIN

into the interstices. At the same time, the waves, being thus checked, deposit more sand along these rough groins than along those of smoother construction.

Rock groins are built usually on the sand, with the base in a rather shallow trench. In some cases on the Oregon coast such groins have been built on a stretch of brush mattress to prevent erosion of the fine sand beneath and around them. Great stability may be given by a line of sheet piling, the top of which projects up into the body of the rock mass.

PERMEABLE GROINS.

With few exceptions, all designs of groins, including those already described, are of the solid type. That is, no water passes through the groin. Even a groin of loose rock permits little flow through it, since the voids or cavities are irregular and often

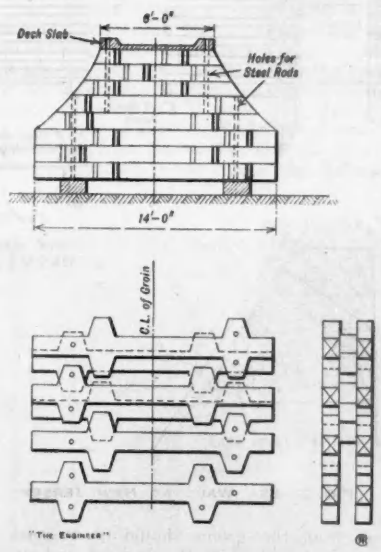


FIG. 22—PERMEABLE GROIN

not continuous, and are likely to be more or less choked with sand and silt.

Permeable groins for beach protection, designed purposely to allow the water to pass freely through them, represent a comparatively modern development which has been applied in a number of cases. The theory of their design is that the littoral or shore currents carrying the sand in suspension are thus not entirely obstructed, but only checked as to their velocity, so that there will be an even deposition of sand on both sides of the groin and along the beach. Solid groins, it is argued, obstruct the flow of the sand-bearing currents, diverting them around the deep-water ends of the groins, and at such velocity as to carry the sand beyond the lee side.

To attain the desired end, and allow for the varying sizes of sand particles or grains, it is considered that the permeability should be greatest towards the seaward end, and should increase from the bottom to the top of the structure. It must be remembered, however, that littoral currents are rather uncertain and variable factors, so that the question of their use at any place must involve a study of the local conditions. In fact, such groins built at Brigantine Beach, on the Atlantic coast, a few years ago were quite unsuccessful. These groins were of timber piling, with spaces between the piles. But such construction was found to constrict the current and increase the velocity of flow through the groins to such an extent as to cause deep scour, so that storm waves would lift the structure bodily out of the sand. The piles were driven 35ft. deep, but gullies were cut between them to depths of 10ft. to 15ft.

The purpose of the permeable beach groins is somewhat different from that of the permeable groynes which have been used extensively for bank protection on many rivers in the United States. The latter are often composed of groups of trees tied together in the trunks and attached to anchor piles, or of lines of barbed wire strung between light steel frames. These river groins, used where a rapid current tends to cut or erode the bank, are intended to catch floating driftwood, leaves and other refuse, which thus gradually form a check to the current and cause the deposit of its sand, silt, and other solid matter in suspension. In this way a bar or foreshore may be built up in front of the threatened bank.

Lake Shore Permeable Groins.—One type of permeable groin has been applied at some points on along the west shore of Lake Michigan, where storm waves and littoral currents have caused serious erosion of the beach and the high ground behind it. This construction, patented by Mr. Sydney M. Wood and Mr. H. A. Schmitt, consists of precast concrete beams having wings or lugs on the sides, so that when built up as a wall or groin the beams in each course form irregular transverse channels for the passage of water. The irregularity of the channels prevents scour.

It will be seen from the drawings, Figs. 21 and 22, that the beams of the several courses are held together and in position by vertical steel rods set in cored holes in the beams. This construction provides sufficient flexibility to allow for minor adjustments due to slight settlement.

The groin is so designed as to have 60 per cent. of voids in the seaward quarter of its length. This proportion then diminishes landward, while the portion across the upper part of the beach may be solid or permeable, according to conditions. The sides may be vertical for the full height, or may slope inward above the water line, thus reducing the proportion of solid wall and the length of channels in the upper part. Flat slabs across the top form a walk-way. In deep water, foundation piles may be necessary, but ordinarily two lines of longitudinal beams form the base support. Care is taken, however, to dig out any pockets of mud or soft material, replacing this with clean sand.

Groins of this type, 350ft. long, built in 1934 at Kenosha, caused the deposit of a great quantity of sand in a few weeks. This formed an excellent bathing beach, with a long flat slope, where formerly the currents had carried away the finer sand and left a rather steep beach of coarse gravel. In the first groins built by Mr. Wood, quarry blocks were used, but the concrete construction is cheaper and simpler, and the beams may be made near the work. In the Kenosha groins, the bottom beams are 14ft. long, and those at the top 6ft. long.

Florida Permeable Groins.—Another and still newer form of permeable groin, used recently on the Florida coast and designed by Mr. G. A. Youngberg, combines steel sheet piling with precast concrete blocks. In this construction the top of the sheeting is just below the beach surface and is surmounted by a wall of concrete blocks, so placed as to leave ample openings for the passage of the water. In this design also the proportion of opening is greatest at the seaward end. These groins for beach protection at Boca Raton are reported as causing a beach depleted by shifting sands to build up and maintain itself in a uniform gentle slope on both sides of each groin.

BEACH AND CLIFF PROTECTION.

Prevention of both beach and cliff erosion is a combination problem along the west coast of Lake Michigan, where earth cliffs or bluffs, 50ft. to 120ft. high, are subject to wash by surface water from above and undermining by waves from below, with consequent slides and falls. A number of residential towns and beach resorts are concerned with this problem. At Sheridan Park, near Milwaukee, the line of the bluffs has been receding at the rate of about 2ft. annually, mainly by wave attack at the toe, but also by erosion of the slope through the action of surface and underground waters.

Underground water is an important factor, as the soil of the bluffs ranges from fine sand to heavy clay in irregular strata, and with many pockets of fine sand. As long as this sand is dry it is stable. But when saturated by rain or seepage water it becomes a flowing quicksand. The weight of the overburden then squeezes out the sand, the earth above collapses, and a large mass of material slides down to the beach. These recurring slides are usually small, but sometimes involve thousands of tons of material, and carry away trees and shrubbery.

Surface water collecting above the bluff and flowing down the slope causes deep gullies, which are aggravated by rain storms. To control this source of erosion the ground along the top of the bluffs was graded or landscaped to slope inland, the water being diverted to catch basins on a storm-water sewer. The face of the bluff was also landscaped and planted

FIG. 23—PERMEABLE GROINS AT SHERIDAN PARK

with shrubs to check the velocity of flow down the slope. Underground water from the sand seams and pockets are carried away by lines of tile drains laid on the face of the slopes. In addition, much of this water is now intercepted by a deep drain laid in a trench, 20ft. deep and 100ft. back from the edge of the bluff. This trench is filled with porous material.

Wave attack along the toe of the slope is the principal cause of the larger slides. Without this factor, the material brought down by erosion would gradually form a protective talus, with a fixed angle of repose and consolidated by a growth of trees and vegetation. But the waves, especially in storms sweeping down the lake from the north-east, continually wash away the *débris* and expose the bluffs to further attack. Some years ago the bluff at Sheridan Park was planted with trees, and a bath house was built on the beach, but trees and building have been destroyed by slides and waves.

Protective Groins.—For the prevention of further destructive action, an offshore breakwater was proposed, but was found to be far too expensive. On the other hand, groins were well within financial reach, and would have the advantage of checking the strong southward littoral drift of the sand, so as to cause the building up of a new beach.

A series of groins has been built, therefore, as shown in Fig. 23, to break up the scouring and eroding waves which sweep in at an angle with the shore line. They are of Mr. Wood's permeable type, in order to cause the deposit of sand and so build up the beach. The twelve groins, about 200ft. long and 200ft. apart, have proved strong enough to resist the fierce storms of winter and have effectually prevented erosion along the foot of the bluff. In about eighteen months the beach had been widened and improved materially by this automatic action of the groynes. The beams, which were made at the site, weigh from 2500 lb. to 6000 lb., according to length, and were placed by a crawler crane travelling along the beach. The construction work on one of these groins is shown

in Fig. 24, with a crawler crane setting the beams in place. A closer view of one of the completed groins is given in Fig. 25.

BEACHES ON THE NEW JERSEY COAST.

The coast of the State of New Jersey has beaches extending almost directly south from New York Bay for a stretch of 125 miles. At the north end is Sandy Hook, a spit of land extending up into the bay. For the first 12 miles below this the beach is at the foot of a cliff or headland. Beyond this is a line of "barrier beaches," narrow reefs or bars, parallel with the mainland and interrupted at intervals by inlets connecting with the waters behind the beaches. Along this stretch of coast are numerous cities, towns, and small settlements, all crowded and

FIG. 24—GROIN AT SHERIDAN PARK UNDER CONSTRUCTION

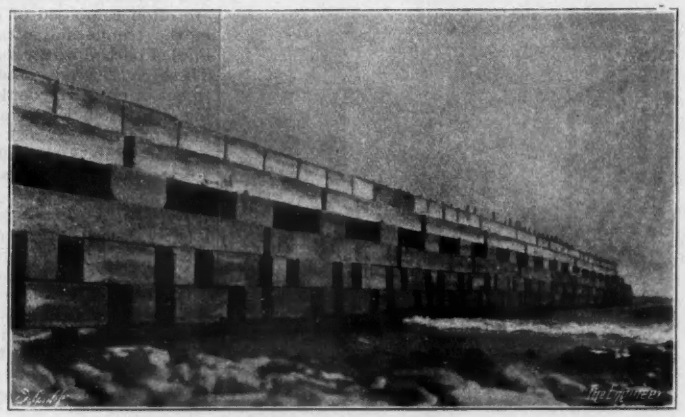


FIG. 25—PERMEABLE GROIN ON LAKE MICHIGAN

busy during the summer, not only with visitors from neighbouring large cities, but also by tourists and summer residents from all parts of the country. The taxable valuation of property is about 800,000 dollars per mile of beach, but should any section of the beach be destroyed the visitors and trade would go to other parts, and most of the value of the deserted town and property would be lost.

According to a report by Mr. Victor Gelineau, Director and Chief Engineer of the New Jersey State Board of Commerce and Navigation, this shore has been receding at the rate of 18in. per year for nearly a hundred years, and a few limited gains or accretions are negligible as offsets to this loss.

Protective works of various designs have been used by municipalities and landowners, but in many cases

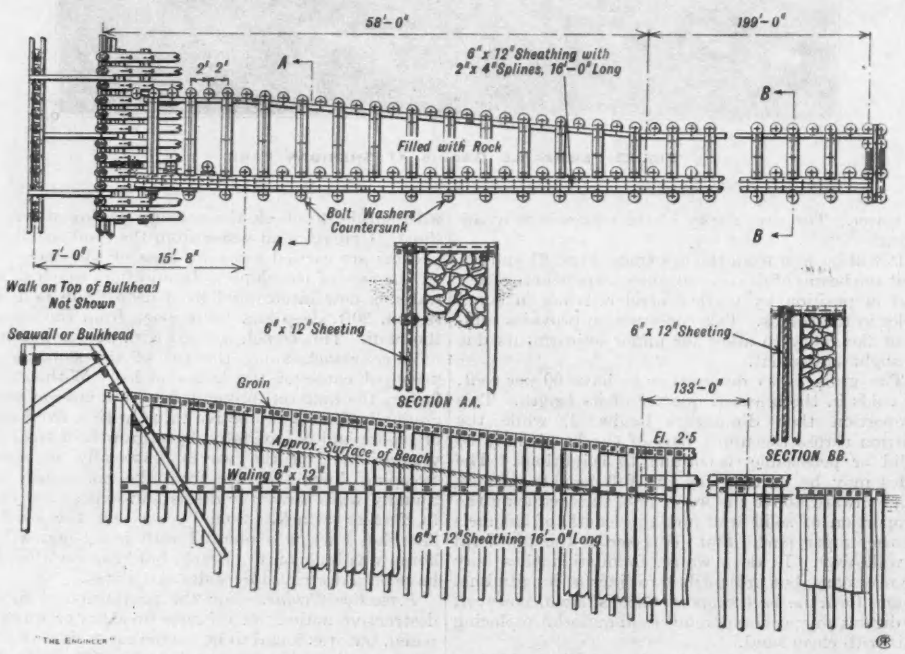


FIG. 26—RAILWAY PROTECTION WORKS AT NEW JERSEY

ineffective, not continuous, or sufficiently substantial. In most cases both a bulkhead or sea wall and a series of groins are used in combination. The groins break up diagonal waves and preserve the beach by checking the southward littoral drift of the sand. The bulkhead prevents erosion of the property behind it. A concrete wall of the stepped type, somewhat similar to the San Francisco sea wall—Fig. 3 *ante*—failed here, owing to the use of wood sheet piling not effectively sealed. Water from waves and spray got behind and under the wall, washing away the sand filling, so that, being undermined and unsupported, it was wrecked during a storm.

In recent years there has been considerable use of steel sheet piling for both bulkheads and groynes along this coast. The piles are of interlocking trough section, with sand-tight interlocking joints. In the groins they are stiffened by waling pieces and supported at intervals by timber piles driven against the waling pieces. In the bulkheads timber anchor piles are driven in the rear and connected to the sheeting by struts and tie-rods, as at Cape May—Fig. 19. Timber groins, built at Asbury Park are typical of work at several points along this coast. They consisted of a double row of round piles—staggered—and sheet piling. One row of 25ft. piles is driven and two waling pieces are bolted along one side. A double line of plank sheeting—or a single line of triple-lap sheeting—is driven against the waling pieces. Similar waling pieces were bolted to the sheeting, and then the second row of round piles was driven. These long piles penetrated a bed of clay underlying the sand. The tops of the groins were practically at beach level or at mid-tide level along the outer end.

RAILWAY PROTECTION WORKS.

A number of the New Jersey coast towns and summer resorts are served by the Central Railroad of New Jersey, which has had to protect its line from the sea at several points, using both the larger and the smaller types of protective works. Typical of the former are the bulkheads and groins of pile and rock construction shown in Figs. 26 and 27.

For the groins—Fig. 26—250ft. long, one side is composed of a line of wooden sheet piling, with waling pieces on each side and between a double row of round piles spaced 4ft. on centres, but staggered to give a 2ft. spacing. The sheeting is of planks, 6in. by 12in. and 16ft. long, with grooved edges, into which are driven wood splines, 2in. by 4in., to form tight and interlocked joints. This form of sheeting is quite different from the modern triple-lap sheeting previously described, in which each pile is built up of three planks so lapped as to form tongue-and-groove joints. The other side of the groin consists of a single row of round piles, 2ft. apart, with a single line of waling pieces. Braces composed of pairs of 2in. by 10in. transverse timbers are fitted between the top wales of the two rows, while between the two timbers is a 1½in. tie-rod extending through the wales and piles. The distance between the two rows of piling is about 4ft. in the outer part, increasing to 8ft. at the shore end. This space is filled with large-sized rocks.

At its shore end, the groin is tied into a bulkhead or sea wall of similar type—Fig. 27—extending nearly 2 miles along the coast. On the property line are round piles spaced 18in. on centres, with a top wale on both sides. About 7ft. outside of these is a row of piles with an inclination of 6 vertical on 4 horizontal, or 1 on ⅔. Braces or struts are fitted between the heads of the vertical and inclined piles. The space between the piles is filled with heavy loose rocks. On the top of this bulkhead, which is about 8ft. wide, is a walk composed of 2in. by 8in. planks, 8ft. 8in. long, and ½in. apart, spiked to longitudinals of the same size, laid flat. This is built up in sections or panels, 12ft. long.

As the bulkhead was built some twenty-five years ago, it has been repaired from time to time as piles have become rotten or broken. Recently it has been reinforced by placing heavy rockwork along its face and rear.

Along the same stretch of beach with the rock-filled groins are thirty-two groins, 200ft. long, which resemble the sheeted sides of the other type. That is, as shown in Fig. 26, each consists of a single line of wood sheeting, with waling pieces on each side backed by two rows of round piles.

From the experience with these works, it is considered that the groins should be at least 300ft. long, and should have the inshore end at about high water level, so that large waves would pass over it in heavy storms.

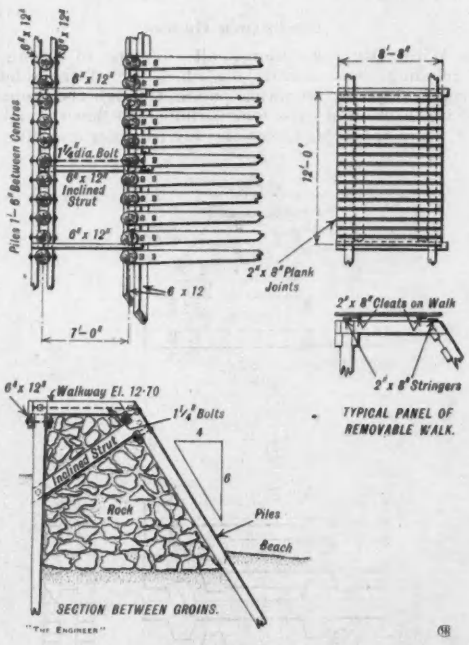


FIG. 27—SEA WALL AT NEW JERSEY

(To be continued.)

THOUSANDS of millions of cubic feet of natural gas have been added to the reserve supply in South-Western Ontario as a result of the past year's well drilling operations, and the threatened shortage of supply that faced the consumers two years ago no longer exists. Many cities and towns and rural communities in that section of Ontario use natural gas for cooking and heating purposes. The city of London, formerly a user of artificial gas, is the latest addition to the list, its supply being obtained by pipe line from the Dawn field in Lambton County, 50 miles distant. The gas-producing beds are situated across the entire south-western portion of the province, from the Niagara peninsula to Lake St. Clair, but the output is especially large in the Lambton-Kent and Welland-Haldimand field. The value of Ontario's natural gas output is close to 5,000,000 dollars annually.

The Dumbarton Valve Works of Babcock and Wilcox, Ltd.

No. I.

SHORTLY before the end of last year we were invited by Babcock and Wilcox, Ltd., to inspect the firm's valve works at Dumbarton, which, under the able administration of Mr. W. L. E. Short, M.I. Mech. E., have from small beginnings shortly after the Armistice now developed into one of the largest and most up-to-date works of its kind. In the accompanying article and the one to follow we propose to describe some of the more interesting features of these works, which have been specially laid out to produce not only seamless tubes but the many valves and boiler mountings which are used in the steam and water services connected with the modern high-pressure plants now employed in the latest steam generating installations, for power station, industrial, and marine services. Fig. 4 on page 120 shows a general view of the works, and in the adjoining engraving, Fig. 1, a general lay-out of the site is given. It is of interest to recall that the original works were those of the "Kosmoid" Company, an undertaking formed for the transmutation of lead to mercury, a process which was, however, never realised, and some of the original buildings designed for this purpose still remain. During the war period they were employed on munition work, but immediately the war was ended work was begun on converting the plant for the production of modern steam valves. The works are designed to operate in close collaboration with the 162-acre parent factory at Renfrew, which, it may be recalled, is solely devoted to the production of boilers and allied power-house machinery, and is complete with its own iron and steel foundries and modern boiler engineering shops, with special welding departments and chemical and X-ray research laboratories.

The Dumbarton Site.

The Dumbarton works are situated on the north bank of the river Clyde, 14 miles west from the city of Glasgow, and are bounded on the north side by the main road from Glasgow to Helensburgh and Loch Lomond, and on the south side by the L.M.S. Railway from Glasgow to Balloch.

The total area of the site, 31 acres, is exclusive of a large housing estate for the employees, the Dumbuck Hotel with its grounds, sports fields, &c. The surrounding countryside, we may remark, is extremely attractive, and the staff and workpeople have every opportunity of pursuing an infinite variety of outdoor recreation, which is often sadly lacking in large towns and densely populated industrial areas.

The four main groups of buildings, as the accompanying engraving, Fig. 1, indicates, comprise the main office and the administrative building, which includes the finished valve store and packing and shipping departments, the calorising department, the valve factory, and the B. & W. tube mill. The works are laid out for the production of valves and seamless tubes, and valves from ¼in. to 16in. bore for pressures from 10 lb. to over 2000 lb. per square inch have been made and tested, while other manufactures include, we noted, soot blowers, oil burner apparatus, and allied equipment, such as tube expanders, tube cutters, and similar accessories, all of which necessitate a high degree of precision and a class of shop routine and machine tool design which is not regularly found in a factory devoted to the production of boilers or other heavy steel products.

The Factory Organisation.

The organisation of the works includes a special department for valve design, which is so carried out that guaranteed performance and complete interchangeability is achieved. The manufacture is planned and is carried on on the "quantity production system" in quantities which are not great enough to enable elaborate "mass production" methods to be followed. Generally speaking, we learn, this entails component parts being manufactured in lots varying from 10 to 500, whilst assembly batches are handled in lots varying from 10 to 50. When any particular valve has been decided upon and all preliminary preparations made, orders known as "stock orders" are issued for quantities of all components required to complete the finished batch of valves. The quantities released, however, are determined by the actual demand, or estimated demand, and raw materials are purchased in reasonable quantities, preventing an excess of raw material stock. In going through the works we were impressed by the modern installation of machine tools, which are fully representative of the best British, American, and Continental practice for the production of highly specialised products.

As Fig. 4 on page 120 shows, the most prominent part of the valve works is a five-storied central building, north of which are the non-ferrous shops, of which the brass machine shop, pattern shop and stores, fettling shop and works offices are in the new additions to the factory which have only recently gone into commission. To the south of this five-storied building are the assembly shops, &c., and heavy machine shop devoted entirely to the ferrous components. The plan given in Fig. 1 indicates the flow of the various materials through the factory. The entire buildings are of modern brick construction and are designed to give maximum daylight; but as production goes on continuously both day and night, great care has been given to artificial lighting of the departments; density of illumination and absence of glare are outstanding features, and portable lamps are used only where the special nature of the work demands them. A modern heating and ventilating system has been installed supplying and distributing throughout the shops warm air in winter and cool air in summer, so ensuring an equitable temperature for the comfort of the workers. The gas and water are supplied by the Burgh of Dumbarton, and electric power is obtained from the grid, the

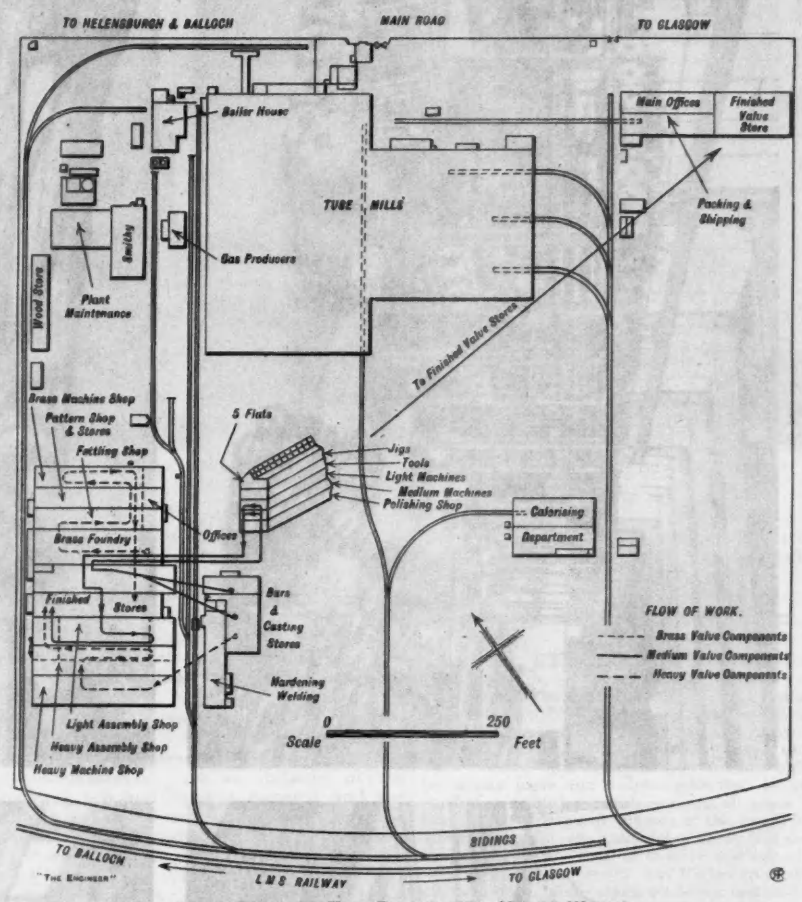


FIG. 1—PLAN OF THE DUMBARTON VALVE WORKS

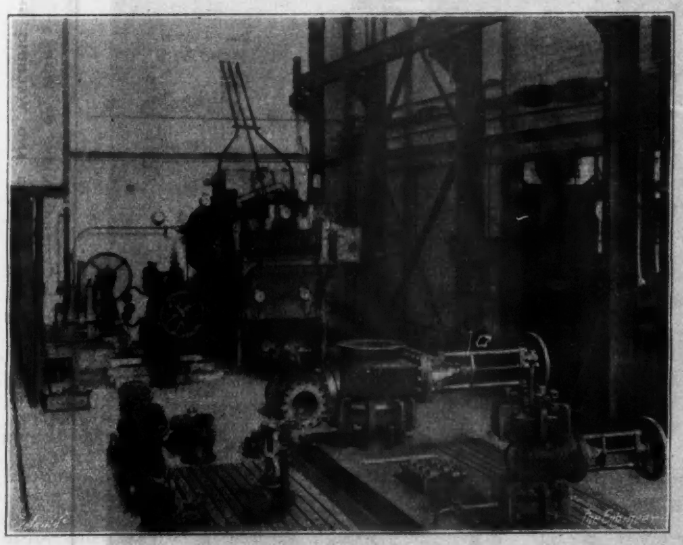


FIG. 2—2000 LB. PRESSURE OIL-FIRED BOILER

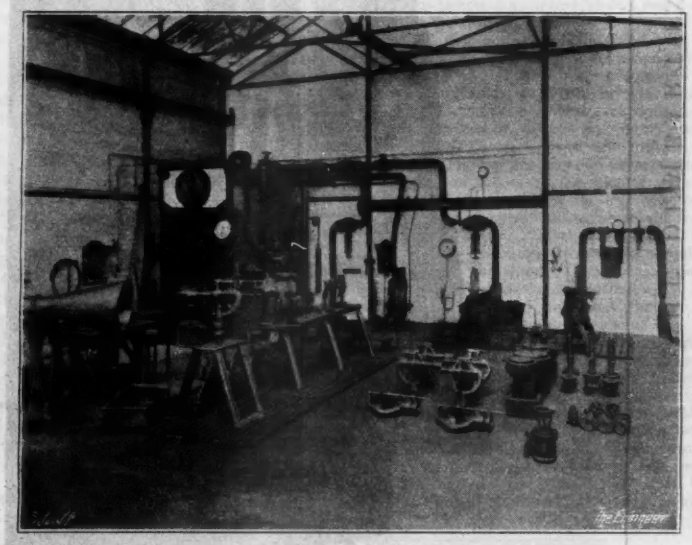
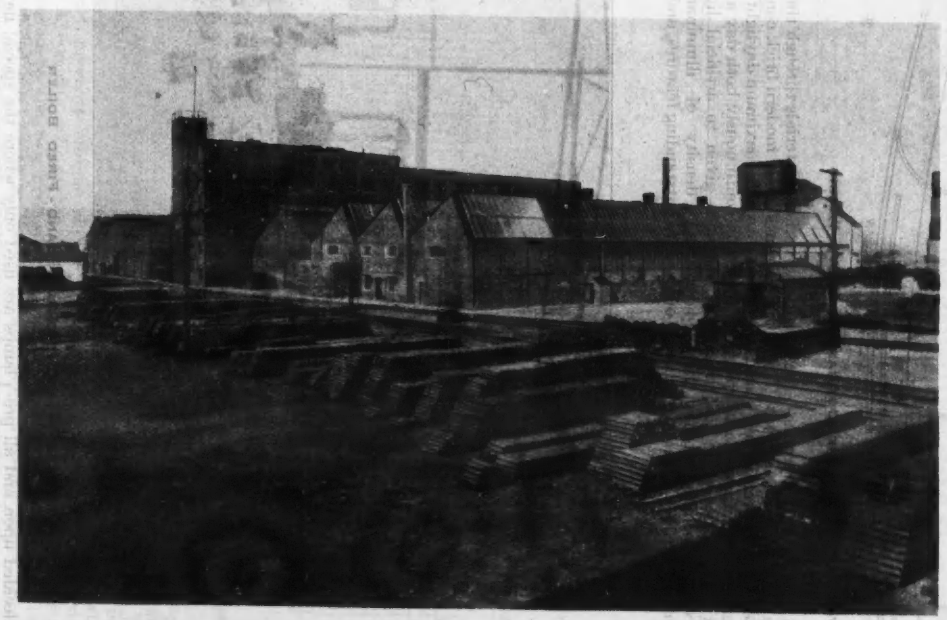


FIG. 3—500 LB. PRESSURE HAND-FIRED BOILER

THE DUMBARTON VALVE WORKS OF BABCOCK AND WILCOX, LTD.



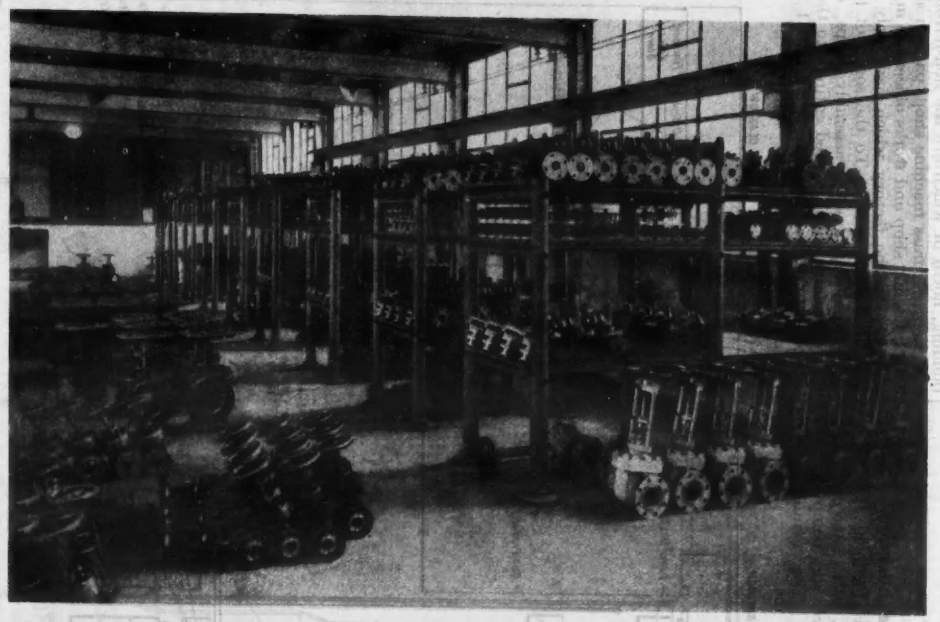


FIG. 4—GENERAL VIEW OF WORKS
FIG. 5—HARDENING AND WELDING SHOP

FIG. 6—FINISHED VALVE STORES
FIG. 7—LIGHT MACHINE SHOP

current used being 440 volts, three-phase, 50-cycle, whilst for cranes and other purposes 220 volt, direct current is obtained from convertors in the factory.

Adjacent to the administrative offices the drawing-offices and the design department, is the finished valve stores, part of which is shown in Fig. 6, page 120. This really forms part of the shipping department, and it may be noted that as a final check on production, inspectors in the shipping department check the dimensions of the valves, type of valve, drilling of flanges, &c., against the order actually received by Dumbarton, entirely separate from the orders issued by the administrative office to the works. This final check against the actual order received typifies the very thorough inspection carried out throughout the routine of manufacture which we noted in the works.

THE CALORISING DEPARTMENT.

A shop of more than usual interest is the calorising department, which is housed in a separate block of

FIG. 8—ELECTRIC SPOT WELDING MACHINE

buildings, in which a number of processes are carried on for the impregnation of certain of the ferrous components by aluminium in a finely divided state. We noted several oil-fired rotating and stationary furnaces which are employed in producing calorised mild steel tubes, case-hardening pots and boxes, air heater tubes, superheater supports and tubes, and soot-blower components. Two grades of treatment are given—ordinary calorising for maximum metal temperatures from 1652 deg. Fah. (900 deg. Cent.) to 1750 deg. Fah. (950 deg. Cent.), and heavy calorising for maximum metal temperatures from 1750 deg. Fah. (950 deg. Cent.) to 1832 deg. Fah. (1000 deg. Cent.). We noted that the products so treated to

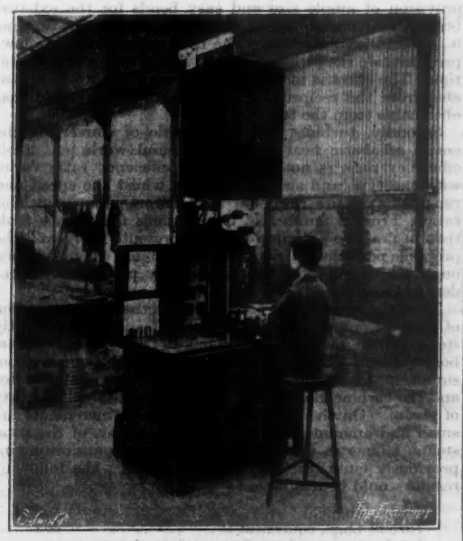


FIG. 9—ROCKWELL HARDNESS TESTER

give them heat-resisting qualities were not strictly limited to the recognised regular products of the Renfrew and Dumbarton works, but also included a large variety of articles subject to high temperatures by various industries. The application of the different processes is governed by the type of service for which the article is destined. Possibly the most striking feature of this department is a battery of electric spot welding machines, one of which is shown in Fig. 8. These machines are principally employed in the welding of the steel nozzles into the soot blower elements.

THE VALVE SHOPS.

The raw materials for the valves are marshalled in specially designed bar and rough casting stores, and include besides bronze castings from the foundry, cast iron and steel parts from Renfrew, and die-stampings from other sources. Adjacent to the rough casting store is the hardening and welding shop—see Fig. 5 on page 120—which is of importance for the heat treatment used extensively in the manufacture of valve seats and facings and expander parts. As these parts are made in a number of different alloys, dependent upon their service conditions, it will be appreciated that this department performs some very specialised operations. In this shop both oxy-acetylene and quasi-arc welding are made use of, and our inspection of welded mild steel bodies for "Victory" valves gave a very favourable impression of the high standard of work. Our engraving gives a general impression of the lay-out of the equipment in this shop, of which the following call for special mention:—Hardening and heat-treating furnaces supplied by Richmond and other special furnaces; also the Tilghman sand blast plant and air compressor, and a large oil-fired annealing furnace, by Howden-Burdon.

The main machine shops are housed in the five-storey building shown on the plan. The top flats are devoted to the jig stores and tool-room, also the inspection departments. As an instance of the multiplicity of jigs and fixtures required and the various inspection processes involved, it may be stated that for the completion of a Babcock "Handor" parallel slide valve the following are required:—Number of component parts, 104; number of tools necessary, 137; number of jigs and fixtures, 46; number of gauges, 174; number of inspecting operations, 116. The basis of all the working gauges is given by a complete set of Johannsen gauge blocks, and a very complete system of gauging is carried out. The tool-room contains a varied selection of modern tool-makers' machine tools, and works in collaboration with a smaller tool-room attached to the brass machine shop, to which we shall return later. Among the special machines employed in checking dimensions and the physical properties of the materials, we may mention the Rockwell hardness testing machine, a view of which is shown in Fig. 9. It measures hardness in terms of depth of penetration, an important point where metals are subject to abrasion, such as a valve seat and disc faces. The machine is essentially a commercial adaptation of the Brinell test, and it may be used by an unskilled operator. It also provides an excellent check on the heat treatment of such parts as expander mandrils and rollers, of which thousands are tested annually, this being one of the routine inspections employed in the factory.

A comparator is used for checking by means of the travel of a beam of light on a graduated scale any inaccuracies of flat surfaces, or in diameter. The travel of 2in. or 3in. of the beam of light indicates an actual difference of respectively two or three thousandths of an inch on the object under examination. As nearly all screw threads in the factory are produced by the milling process an accurate means of comparative inspection of threads is essential. For this purpose the projection apparatus shown in Fig. 10 has been installed, and is used in addition to the system of checking screw threads by three wires and micrometers. The apparatus projects an image of the screw thread on to a screen with a magnification of 50. It provides, therefore, a simple and extremely accurate method of checking the form and pitch of the screw thread gauges, since an error of one-thousandth of an inch is shown as 0·05in. Gauges for special profiles can also be shown and accurately checked by the apparatus against an enlarged drawing of the actual profile.

Other routine tests include, we noted, both hydraulic tests and steam tests, and facilities are available for hydraulic pressures up to 5000 lb. per square inch, and steam pressures up to 2000 lb. per square inch, and a temperature of 1000 deg. Fah. Fig. 2 shows an oil-fired B. and W. boiler for a pressure of 2000 lb., whilst Fig. 3 shows a hand-fired B. and W. boiler for steam pressures up to 500 lb. per square inch. After testing the gland packing is removed from the stuffing-box of the valve, and those valves for service in Great Britain are repacked immediately before shipment with new gland packing, whereas with those valves destined for abroad the packing is shipped separately. The steam test is of particular importance for safety valves, and covers an accurate setting of the valve for the required release and closing pressures.

Fig. 7 on page 120 shows a typical view in the light machine shop, and we shall deal more especially with this department in our next article.

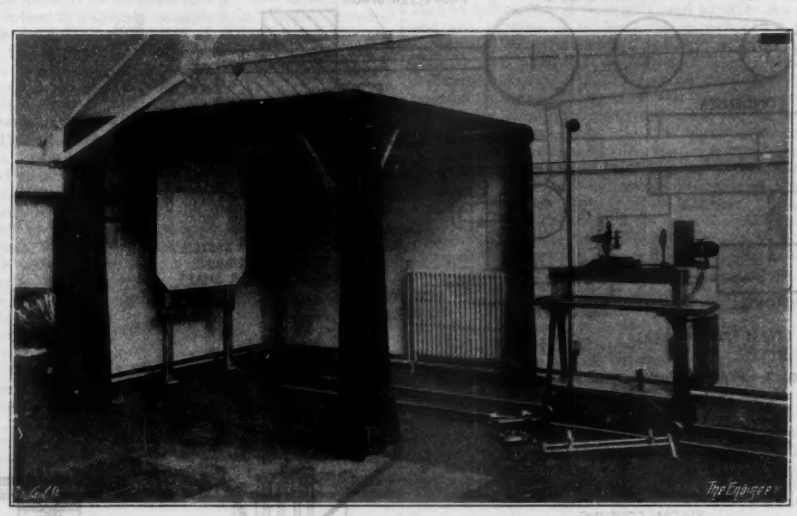


FIG. 10—OPTICAL PROJECTION EQUIPMENT

(To be continued.)

THE DECAY OF WOOD.

A LECTURE on the decay of wood was given on Wednesday, January 22nd, under the auspices of the Timber Trades Technical Education Committee, by Dr. E. A. Rudge, of Cardiff. The lecturer pointed out that the term "decay" was interpreted in so many different ways by timber users and technologists that he proposed to employ a definition which covered all cases. This was based upon a chemical analysis of the wood, for, he said, all investigators were agreed that decay was accompanied by a change in the total or relative amounts of the major constituents of the wood. Dr. Rudge proceeded to summarise his own observations on decay, and said that decay always required a minimum of about 20 per cent. of water, and was always associated with the infiltration of certain mineral compounds into the wood. The effects caused, whether dry rot, wet rot, or humification, depended upon the relative amounts of water, air, and mineral matter. Thus, with less than 40 per cent. water, fungus attack was the prevalent development. The substances which he had found in every case to be associated with decay were lime mortar, lime plaster, Portland cement, and other materials of which calcium carbonate was an ingredient, and also iron nails, and rust. On the other hand, he had not found any cases of decay associated with plaster of paris, aluminous cement (*ciment fondu*), common salt, or copper, zinc, or galvanised metal.

Even in the case of dry rot—the stronghold of the biological theory of decay—the same association with lime was always found. The lecturer quoted references in technical literature dating back to 1703, in which the association of lime with decay had been recorded, and pointed out that that view of decay was completely eclipsed by the theory of Pasteur about the middle of the nineteenth century. The system of wood preservation by creosoting, he said, was traced to the master patent of Bethell, in 1838—before Pasteur's theory was put forward—and in that patent specification he could find no mention of antiseptic action. Bethell appeared to have one clear idea in his proposed treatment, namely, the blocking of the pores of the wood. Creosote occupied a quite insignificant place low down in Bethell's list of suitable liquids. Dr. Rudge said that his theory of infiltration had met with considerable criticism, but in fairness to it he would like to point out that the biologist had not proved that a fungus spore could start decay. Of all building materials we knew least about timber, he stated, and we would not progress in our knowledge by reclining on old, conventional ideas. If the public confidence in timber as a material of construction was to be increased, timber technologists must learn more concerning the scientific principles involved in the processing of timber. To that end they could not afford to ignore any new ideas, however unorthodox they might appear.

IN consequence of the present state of national mourning the launching of a passenger motor ship for India from the yard of Henry Robb, Ltd., Leith, which was to have been performed by Lady Linlithgow, was carried out on Saturday without ceremony, the vessel being placed in the water unnamed. The name of the ship, the "Saint Anthony," will be covered until a special naming ceremony is carried out towards the end of next month, after the engines have been installed. The "Saint Anthony" has been specially designed for coastal passenger service from Bombay to the islands south of the port.

Exhaust Steam Turbines for Marine Propulsion.*

By J.-B. O. SNEEDEN, Ph.D., B.Sc., A.M.I. Mech. E.†

Introduction.—The problem of utilising exhaust steam from reciprocating engines in low-pressure turbines seems to have originated in 1837, according to a patent taken out by Sir James Anderson. Again, in 1846, a similar patent was taken out by Sir H. Bessemer. It was not, however, until 1902 that the scheme was put into practice by Sir Charles Parsons in this country and by Professor Rateau in France, whilst the first marine installation of any consequence was the combination machinery of the ss. "Otaki," built by Messrs. Denny Brothers, of Dumbarton, in 1908. This was followed by several similar installations in the ships of the White Star Line, but very soon afterwards the combination system was abandoned altogether.

It is surprising to find that in spite of the fact that the earlier type with direct turbo-drives had shown its practical value, the present-day systems should have been so long in making their appearance. This delay is probably due to the successive rapid development of the single and double reduction geared turbines, followed in 1920 by the introduction of the oil engine in marine work. Now, however, the combination type of steam machinery is beginning to receive the attention it deserves.

Basis of Comparisons.—Much has been written and argued on the subject of the economies of such combination machinery. Fuel coefficients have been discussed, and conclusions have been derived as to the superiority of one system over another. The author believes that these coefficients do not constitute a satisfactory basis of discussion, since they introduce several variable factors, such as propeller efficiency and hull form, which are distinctly extraneous to the proposition. It can even be said that the coal consumption per indicated horse-power hour does not provide a true criterion of the economy of the power machinery system, because such a figure includes the performance of the boiler plant; whilst it can be further argued that the results of sea journeys by sister ships over the same track should be used with the greatest reservation.

Since the heat engine is a mechanical contrivance for the transformation of heat energy into mechanical energy of rotation, and since the transformation is carried out in the engine room independently of such factors as the state of the weather, tide, &c., and of what is happening on the boiler side of the bulkhead, it can be said that the heat consumption per indicated horse-power hour under similar conditions of heat availability is probably the only true criterion of the efficiency of the system.

The transformation of energy takes place partly in one or more sets of engines producing useful work—the main or propelling unit—and partly in one or more sets of auxiliary engines producing work that is useless in propulsion, but necessary for the proper operation of the main engines. It could therefore be contended that the heat consumed per hour should include that required by the auxiliaries. Allowance for this could be made by considering the product of the total feed to the boiler per hour and the heat in the generated steam, reckoned above the heat in the feed supply. No particular purpose would be served by the inclusion in the results of the auxiliary power represented by this heat consumption. On the contrary, by excluding this quantity and considering the power obtained from the propelling engines alone, a better idea could be formed of the relative merits of machinery systems. At the same time the plant should be credited with any benefit that may be derived by a proper utilisation of the auxiliary exhaust steam, *e.g.*, for heating the feed water, or increasing the work developed in the main engines when the auxiliary exhaust passes to them. The following figures have been compiled from the results of a four-hour trial of a triple-expansion engine:—

Total steam consumed per hour, lb.	20,124
Pressure of steam at supply, lb. per square inch absolute	230·4
Temperature of steam at supply, deg. Fah.	535·7
Temperature of feed at boiler, deg. Fah.	206·3
I.h.p. developed by main engines*	1,621
Heat consumed per i.h.p. hour, B.Th.U.	13,848

* Exhaust steam from auxiliaries condensed in auxiliary exhaust heater, and condensate drained to hot well.

Problems Arising Out of the Introduction of the Exhaust Turbine.—Before considering exhaust turbine systems, it is advisable to examine a few of the problems that arise in practice when a turbine is introduced between the low-pressure cylinder and the condenser. First, in spite of the provision of ample size and easy bends for the exhaust branch between the low-pressure cylinder and the turbine, it is found invariably that the back pressure on the low-pressure side rises whenever the turbine comes into operation. The effect is to decrease somewhat the work obtainable from the reciprocating engine and to increase that obtainable from the turbine.

Secondly, turbines are not capable of converting the entire adiabatic heat drop into useful work, *i.e.*, their efficiency ratio is not unity. The efficiency ratio varies with the type and size of turbines, whilst the speed and range of pressure drop are also factors influencing this ratio. From a number of observations the author finds that in practice a figure of 0·65 represents fairly well the probable performance ratio of such turbines when reckoned on the adiabatic drop between supply pressure and condenser vacuum.

Thirdly, the auxiliaries, which, with the usual exception of the air pump, may be taken as being independently steam driven, may consume about 10 per cent. of the total boiler steam. They will now require a slightly higher consumption, whilst the air ejector for the vacuum augmentor and the turbine glands will require an additional quantity of steam. On the whole, however, these increments are small and amount to from 1 to 1½ per cent. of the total steam. Thus in the case of the triple-expansion engine previously cited, with its exhaust turbine, the following results would be available:—

Engine, i.h.p.	1,521
Turbine i.h.p., equivalent to	605
Total steam per hour (increased by 1 per cent.), lb.	20,325

Fourthly, some consideration must be given to the heat taken in by each pound of steam generated. It is the practice in the type of plant under consideration to utilise the exhaust steam from the auxiliaries for feed-heating purposes. When the exhaust turbine comes into action, the increased vacuum is accompanied by a fall in the condensate temperature, and the hot well temperature will drop. Hence, in spite of the slight compensating effect of the increased auxiliary consumption, the feed temperature at the boiler will be lowered, and the heat consumption per pound of steam will be increased.

Fifthly, the condensing plant should receive some attention on account of the greater duty it may be called upon to discharge. The circulating water pump must be worked faster and the condensing surface must be increased about 6 to 15 per cent. more than that of the simple design.

Sixthly, the treatment received by the reciprocator in some types of combination machinery should be realised.

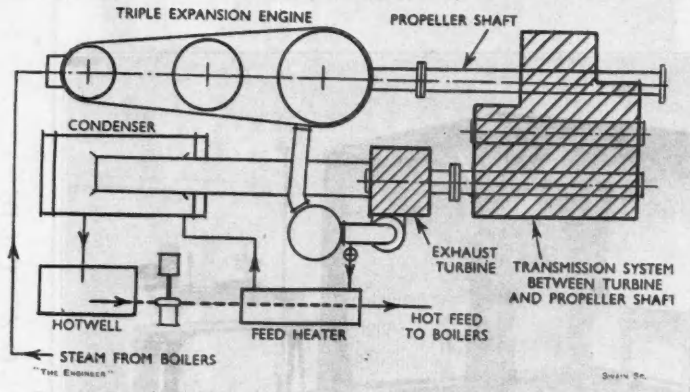


FIG. 1—*Exhaust Turbine and Flexible Mechanical Connection to Propeller Shaft.*

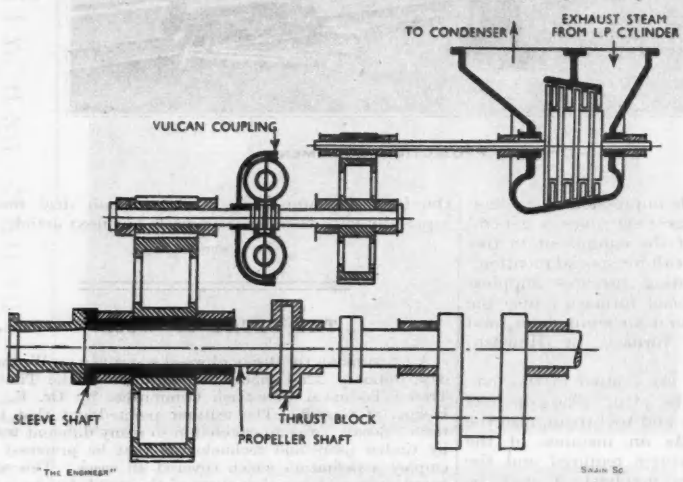


FIG. 2—*Diagrammatic Arrangement of Bauer-Wach Transmission.*

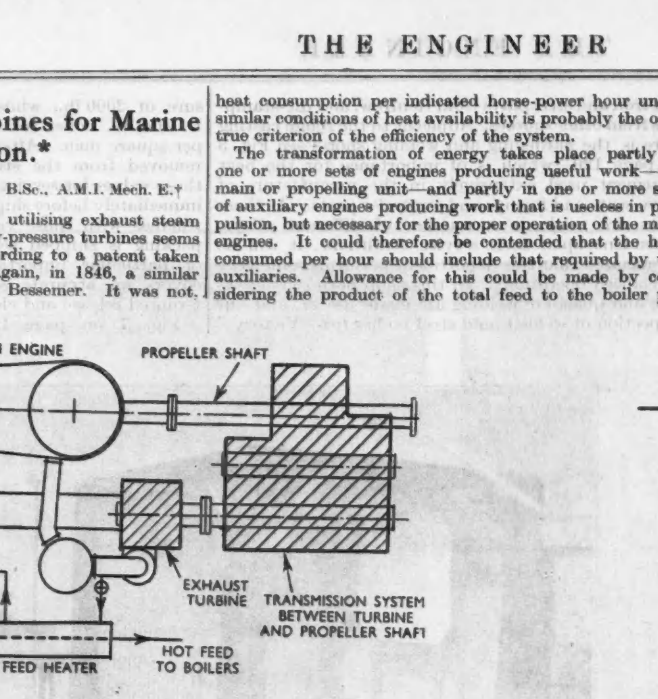


FIG. 3—*Diagrammatic Arrangement of Brown-Boveri Transmission.*

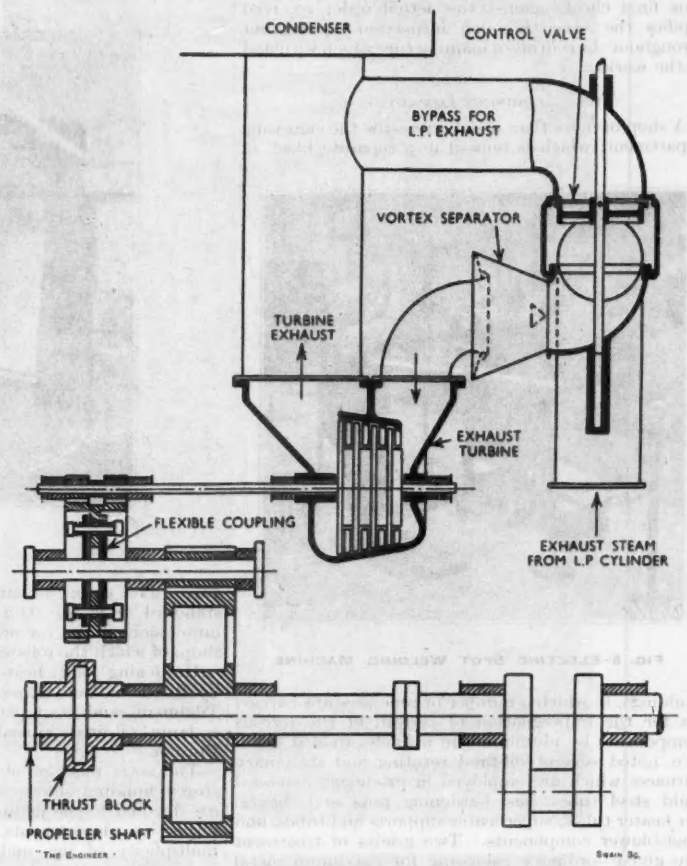


FIG. 4—*Diagrammatic Arrangement of Parsons Transmission.*

* The Institution of Mechanical Engineers, January 24th. Abstract.

† Lecturer in Heat Engines at the Royal Technical College, Glasgow.

Where the combined engines and turbine are designed to operate most economically under full-power conditions, the reciprocator, when worked alone to establish comparative consumptions, will obviously be grossly overloaded and will therefore enable the combination machinery to show to better advantage. As an example, the results of ss. "Britannia" may be quoted. The combination machinery gives 5022 h.p., divided in the proportion of 3707 h.p. in the engine to 1315 h.p. in the turbine. When operating alone, the reciprocating engines develop 5026 h.p. —*i.e.*, 35 per cent. more power is developed by the engines, unless it is to be interpreted that the engines are designed for 5000 h.p., when the performance will be adversely affected with the turbine in operation; but such a supposition seems hardly correct.

Up to the present, four groups of systems have been designed for turbine combination machinery.

(1) The Mechanical Coupling Group.

This group comprises three well-known types—Bauer-Wach, Brown Boveri, and Parsons. Although three

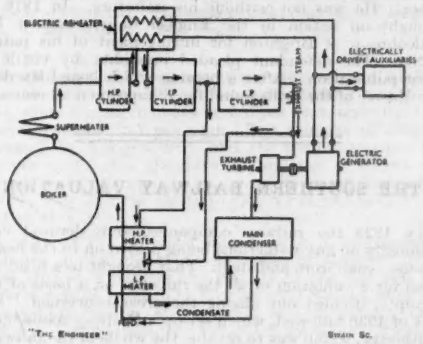


FIG. 5—*Diagrammatic Lay-out of Lindholmen System.*

different methods are employed for providing a flexible coupling between the turbine shaft and the propeller shaft, yet the principle is identical (Fig. 1). The results of trials of such machinery, both as conversions and as new installations, have been extensively published. But it is perhaps appropriate to include the possibilities of this system, so that some idea may be formed of the comparative value of each system when applied to a common prime mover, namely, the triple-expansion engine already mentioned.

Probable Economy.—The turbine transmits power through two stages of reduction gearing and thereby suffers a loss, which may be increased in various degrees, depending upon the type of coupling employed. Assuming the combined efficiency of the various transmission members to be approximately equal to the mechanical efficiency of the reciprocating machinery, then the indicated horse-power of the turbine can be directly added to that of the engine. It has already been stated that the available turbine indicated horse-power is 605; thus the total indicated horse-power available for power purposes is 2126. Hence the heat consumption per indicated horse-power hour is 10,820 B.Th.U., and the saving to be expected amounts to 22·1 per cent.

Advantage may be taken of the pressure drop between the low-pressure exhaust branch and the condenser, when the turbine is in operation, by the introduction of a low-pressure feed heater. In such a heater the temperature of the feed water may be raised by steam extracted from the low-pressure cylinder exhaust, the heat consumption of the unit being thereby reduced at the expense of the output of the turbine. Making certain assumptions, the heat consumption per indicated horse-power hour would then be 10,600 B.Th.U., and the saving 23·5 per cent. In addition to the improved economy due to the low-pressure heater, the heat rejected to the condenser is diminished, with beneficial results to the condensing plant.

The Bauer-Wach System.—In this system (Fig. 2) exhaust steam from the low-pressure cylinder is supplied to the turbine through a change-over valve and an oil separator. The turbine is of the Parsons type, running at 3000 r.p.m., and may be of the single-flow or double-flow arrangement. The turbine output is transmitted through two stages of reduction gearing and a Vulcan hydraulic coupling to the engine propeller shaft. The coupling can be situated on the intermediate shaft, either at the end or between the intermediate gear wheel and second pinion. The turbine is built for ahead running only and therefore during manœuvring operations it must be put out of action, and the exhaust steam by-passed to the condenser. The total number of ships fitted with the system is well over 250, including installations of powers from 650 to 17,500 i.h.p.

The Brown Boveri System.—In this arrangement the turbine is of the reaction type, and its output is transmitted to the propeller shaft through a very elaborate and yet extremely simple elastic system, consisting of two stages of reduction gearing and an elastic coupling. Fig. 3 shows the first reduction wheel and the second reduction gear mounted each on a sleeve A connected to an internal shaft B at its extremities. The second reduction gear wheel is similarly mounted on a sleeve C round a through shaft D, and the end of the sleeve carries one half E of the elastic coupling, whilst the second half F is connected to an independent sleeve keyed to the through shaft, which itself is part of the propeller shaft. The teeth on the gears are cut in such a direction that the thrusts are counterbalanced by those of the turbine and propeller shafts. The two halves of the elastic coupling are interconnected by several pairs of spring cylinders. This method of connecting the coupling to the propeller shaft has the advantage that the turbine system is independent of the reciprocating engine. The object of the coupling is to damp oscillations and compensate for the varying torque from the main engines, and also to render the connection self-aligning. The turbine is of the single-flow reaction type, designed to run at 3400 r.p.m., but an astern turbine is provided in the same casing. Both ahead and astern turbines are supplied with live steam during manœuvring and reversing operations, while the low-pressure exhaust steam is by-passed to the condenser. The change-over is brought about through oil-operated valves, controlled by the reversing gear.

The Parsons System.—Here also the turbine output is delivered to the propeller shaft through double-reduction gearing, and a flexible coupling (Fig. 4). The turbine is of the single-flow reaction type, without astern wheels. In consequence the exhaust steam is by-passed to the condenser during manœuvring and the turbine allowed to idle in a vacuum.

Reference should also be made to the attempt at simplicity by the Danish Elsinore Shipyard in the Christensen engine, where the exhaust turbine is coupled to the propeller shaft by a chain drive.

(2) The Electrical Coupling Group.

In this group, two types of installations, similar in their basic principle, but different in their application, have so far been constructed—the Metropolitan-Vickers and the British Thomson-Houston. In the Metropolitan-Vickers system, the electric generator is driven by the exhaust turbine through single-reduction gearing and the current supplied to the propelling motor, which is fitted direct to the propeller shaft. During manœuvring, the additional propelling machinery reverses with the engine. Further, in some cases a live steam connection to the turbine is provided, so as to render the auxiliary power available in case of the breakdown of the main engines.

In the British Thomson-Houston system, the generators are directly driven by the exhaust turbines, and the propelling motor is fitted, as in the previous case, to the propelling machinery just aft of the thrust blocks. As each alternator is directly connected to a propelling motor, the additional propelling machinery cannot remain in commission during reversing and manœuvring. The controls are suitably interlocked in order that the motors may operate only when the reversing gear is in the ahead position. A live steam connection to the turbine is provided, as in some of the Metropolitan-Vickers installations.

Since the efficiency of the various stages of energy transformation is very high in this arrangement, the overall efficiency from turbine shaft to the propeller shaft will again be about 92 per cent.; that is to say, it is possible to assume that the additional indicated horse-power available for power purposes will be almost equal to that obtaining in installations of the first group. Hence the saving in heat consumption per indicated horse-power hour will be approximately 22 per cent.; with steam extraction at the low-pressure exhaust, 23·5 per cent.; and with further steam extraction at the intermediate-pressure steam chest, 24·5 per cent. Some additional economies may be obtained in this system by the substitution of electric drives for all the auxiliaries, at the expense of a re-arrangement of the turbo-electric units, since during manœuvring the turbine will be required to generate sufficient current to feed the auxiliary motors.

(3) The Heat Coupling Group.

Since any energy derived from the exhaust steam of a reciprocating engine is a recovery of what otherwise goes to waste, it follows that the reintroduction of the recuperated energy into the system is bound, in general, to lead to a saving in heat consumption. However, the form which this transformation takes is of paramount importance. It may take place in such a manner that most of it is immediately available as mechanical work, or it may take place in such an irreversible manner that most of it is again rejected, in which case the saving may be nil. In the Lindholmen regenerative system, as installed in ss. "Trione" in 1931—see Fig. 5—the energy from the exhaust turbine is first transformed into electrical energy. Part of this electrical energy is used to drive the auxiliaries and the surplus is utilised for superheating the steam supply. Thus the turbine energy is partly expended directly and partly in the form of heat regeneration at constant pressure, and therefore the saving actually realised is intermediate between that due to the first (mechanical coupling) group and zero. If the boiler steam is already superheated, the electrical superheating can only be applied either to the exhaust steam from the high-pressure cylinder, as in ss. "Trione," or to that from the intermediate-pressure cylinder. The saving due to superheating, say, the high-pressure exhaust would be two-fold. First, there would be the thermodynamic gain obtained by raising the initial state point of the steam in the heat-entropy field. Secondly, and of far more importance, there is the economy due to the reduction of condensation and leakage of steam on entering the intermediate-pressure cylinder. But it must be emphasised that since this economy (already comparatively small) is brought about at some intermediate point in the total expansion of the steam, its effect on the overall performance must necessarily be of minor value. With a saturated steam plant, the application of superheat by the Lindholmen system might lead to more satisfactory results.

In practice, it is found that when the exhaust steam from the high-pressure cylinder is reheated, the receiver pressure is immediately increased, due no doubt to the increased specific volume of the reheated steam. The result is that a redistribution takes place of the total work done in the high-pressure and intermediate-pressure cylinders. Less work is done in the high-pressure, and slightly more in the low-pressure cylinder; but it may happen that these quantities balance so that there is no increase in total power.

(4) The Regenerative Group.

The Götaverken System.—In this system, invented by the Swedish engineer Johansson, the energy developed by the turbine is returned to the working steam at some intermediate stage in its expansion, usually at its exhaust from the high-pressure cylinder. It must not be thought that it is, in effect, a repetition of the Lindholmen system, for whereas in the latter the energy is transformed into temperature energy in an irreversible manner, in the Götaverken system the transformation into pressure and temperature energy takes place in what could be regarded in the ideal case as a perfectly reversible operation, namely, an adiabatic compression.

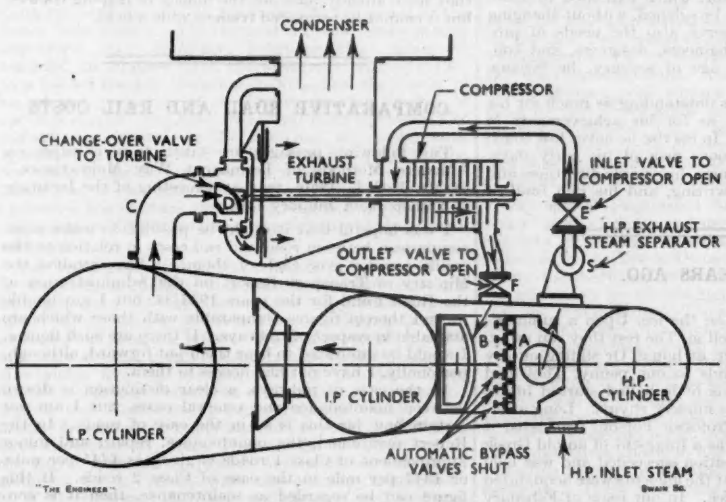


FIG. 6—*Diagrammatic Arrangement of Rowan-Götaverken System : Compressor In.*

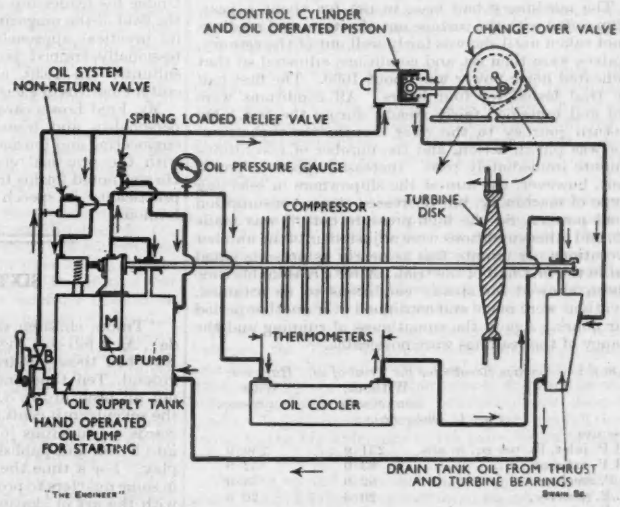


FIG. 7—*Diagrammatic Arrangement of Oil Relay, Lubrication, and Control of Change-over Valve*

The general arrangement of the turbo-compressor, engine, and condenser in the Rowan-Götaverken designs is shown diagrammatically in Fig. 6. The triple-expansion engine is of standard type, with the exception of the intermediate-pressure steam chest, which embodies certain special features. This chest is divided into two compartments A and B. A forms a receiver for the high-pressure exhaust steam, and B forms the supply chest to the intermediate-pressure cylinder. The dividing wall is fitted with a number of automatic valves, which open into the intermediate-pressure steam chest. When the exhaust turbine is out of action, the automatic valves are kept open by the flow of steam. The pressure drop from one side of the valves to the other rarely exceeds 2 lb. per square inch.

The compartment A is connected through separator S and valve E to the suction or low-pressure side of the compressor, while compartment B is connected through a valve F to the delivery or high-pressure side. These valves are both closed when the compressor is idle, and both are open when it is working. After doing its work in the intermediate and low-pressure cylinders, the steam exhausts into the pipe C, and it can then either flow direct to the condenser or enter the turbine. The change-over is brought about by valve D, through a small hand-operated oil pump.

When the turbine is brought into action, valves E and F are open, and the change-over valve D is in the position

shown in Fig. 6. The compressor produces a drop in pressure in compartment A and a rise in pressure in compartment B. This pressure difference ensures the closing of the automatic valves.

The control of the change-over valve will be understood from Fig. 7. With the turbine at rest and no oil pressure in the turbine lubricating system, the change-over valve is kept open to the condenser by means of the spring-loaded piston in the control cylinder C. If the shut-off valve B is now opened, and the hand pump P operated, a few strokes will build up a pressure in the oil line from B to C. When the oil pressure is sufficient to overcome the load caused by the spring in C, the piston moves to the right and swings the change-over valve to the turbine inlet. The turbine will then start and the main oil pump M, driven by gearing from the turbine shaft, will maintain the necessary pressure in the control cylinder C. The shut-off valve is closed as soon as the pressure of the oil reaches the normal working value, about 20 lb. per square inch.

The turbo-compressor is thus entirely independent of the engines, and can only be maintained in action by the pressure of the oil in the control cylinder C. Should this pressure fail to overcome the pressure of the spring, either through the failure of the lubricating system, or through the action of the governor and oil escape valve when the turbine speed becomes excessive, the turbo-compressor is cut out and the engine functions normally.

The absence of gears and mechanical connections is possibly one of the most outstanding features of this system. It renders manœuvring and reversing extremely simple, as the turbo-compressor adjusts itself to the requirements of the occasion. The turbo-compressor is a single self-contained unit, with the exhaust turbine mounted on the same shaft as the steam compressor. The rotors are statically and dynamically balanced, and run at 6500 r.p.m.

The unit is very compact and can be easily accommodated in the ordinary engine room. It is usually mounted on top of the main condenser, either on a separate platform supported from the engine frame or on the top of the condenser itself. It is usual in Rowan-Götaverken designs for a rotary feed-water pump to be incorporated with the turbo-compressor unit. The feed pump is directly driven by the turbine, and is mounted at one end of the compressor shaft. The addition of the centrifugal pump at this point introduces a slight complexity into the layout of the piping system. On account of the inability of such pumps to produce a suction effect or to lift the feed from the filter tanks without danger of cavitation, it is necessary to provide the feed to the pump with a head of 3ft. to 4ft. With this object, the ordinary feed pump is kept working when the turbine is in operation, but instead of delivering the feed through all the heaters into the boiler under high pressure, the reciprocating pump delivers the feed through the low-pressure heater into an overhead tank placed at a height of about 6ft. above the centrifugal pump. The latter discharges through the auxiliary exhaust and high-pressure heaters into the boilers.

Practical Applications.—The first combination machinery installed by Messrs. Rowan was for the ss. "Harlingen," belonging to the Harrison Line, in 1933; but due to lack of time it was not then possible to carry out a complete trial to ascertain the saving due to the compressor unit. However, at the beginning of last year a loaded trial was conducted from Newcastle into the North Sea. The machinery had been in use for about a year. The ship sailed with the turbine out of action, and readings were not taken until she was fairly well out of the estuary. The valves were then set and conditions adjusted so that the indicated horse-power was about 1600. The first half of the trial lasted for four hours. All conditions were normal and remained fairly steady during the test. On the return journey to the river mouth, the turbo-compressor was put in action, and the number of revolutions per minute immediately rose. Increased speed or power was not, however, the aim of the shipowners in selecting this type of machinery, but decreased steam consumption at equal power. So the high-pressure cut-off was made earlier, and other conditions were adjusted until the number of revolutions per minute was as nearly as possible equal to that in the first half of the trial. After a reasonable time had been allowed for steady conditions to be attained, observations were made and continued over another period of four hours. Again, the smoothness of running and the constancy of the readings were noticeable.

TABLE I.—*Average Results for the Trial of ss. "Harpasa."*

	Without compressor.	With compressor.
Part I.: Observations.		
Pressures :—		
H.P. inlet, lb. per sq. in abs.	231·0	230·0
H.P. exhaust, " "	63·0	52·0
I.P. receiver, " "	62·0	78·0
L.P. receiver, " "	20·3	20·5
L.P. exhaust, " "	2·85	4·24
Condenser (vacuum, inches of mercury)	27·82	29·64
Temperature, deg. Fah.:—		
H.P. inlet	540·5	537·5
H.P. exhaust	307·3	311·0
I.P. receiver	304·5	359·0
L.P. receiver	224·0	224·5
L.P. exhaust	145·0	158·0
Top of condenser	102·5	74·7
Condensate	77·6	79·2
Hot well	94·6	95·2
Inlet to L.P. heater	—	92·3
Outlet from L.P. heater	—	150·5
Outlet from overhead tank	—	153·8
Inlet to exhaust heater	97·3	152·0
Inlet to boiler	184·2	229·9
Inlet circulating water	48·0	48·4
Outlet circulating water	84·6	63·5
Feed water, lb. per hour	19,599	16,730
Speed, r.p.m.	66·55	67·60
Part II.: Deductions from Observations.		
I.h.p. (average, allowing for area of piston-rods) :—		
H.P. cylinder	618	601
I.P. cylinder	485	588
L.P. cylinder	503	425
Total	1,606	1,614
Total heat per pound, B.Th.U.:—		
Steam at engine stop valve	1,291·8	1,289·7
Feed at boiler check valve	152·2	198·0
Heat in steam	1,139·6	1,091·7
Heat supplied per hour	22,335,020	18,264,141
Heat supplied per i.h.p. hr.	13,907	11,316
Net saving, with turbo-compressor, per cent.	—	18·6

After the experience gained with their first three installations, Messrs. Rowan made several alterations to the relative sizes of the cylinders of the reciprocating machinery and to the situation and adjustments of the automatic by-pass valves. Two sister ships which soon followed, the "Harpasa" and the "Hartlebury," were fitted with triple-expansion engines, cylinder diameters 22½in., 36in., and 65in., stroke 48in., and piston-rods 6½in. in diameter, and designed for supply conditions of 230 lb. per square inch absolute and 550 deg. Fah. These vessels were both tried in the Firth of Clyde and showed savings in heat consumption per indicated horse-power hour of 18·6 and 18·3 per cent. respectively. Independent readings were taken on the trials of the "Harpasa" at intervals of ten minutes by Professor A. L. Mellanby, Dr. J. F. Shannon, and the author. The average results for the trial of the "Harpasa" are given in the first part of Table I, and the deductions in the second part of the same table. The heat account is given in Table II.

TABLE II.—*Heat Account.*

British thermal units per pound of feed.

	Without compressor.	With compressor.
Total heat in steam leaving boiler	1,291·8	1,289·7
Heat in condensate	45·5	47·1
Heat added in hot well (from drains)	19·6	16·0
Heat added in L.P. heater (from steam extracted at L.P. exhaust)	0·0	55·2
Heat added in exhaust heater (from auxiliary steam)	87·1	79·7
Heat added in boiler (from fuel)	1,139·6	1,091·7
Heat to indicated work	208·6	245·6
Net indicated thermal efficiency, per cent.	18·3	22·5

OBITUARY.

FRED R. LOW.

MANY British engineers will be sorry to hear of the death of Mr. Fred R. Low on January 22nd, at his home in New Jersey, where he had been critically ill for several years. He was seventy-five years of age.

He was editor emeritus of *Power*, following forty-two years (1888–1930) as its chief editor, a Past-President of the American Society of Mechanical Engineers, an Honorary Member of the Institution of Mechanical Engineers, and Honorary Doctor of Engineering, Rensselaer Polytechnic Institute. At the time of his death he was still Chairman of two important committees of the American Society of Mechanical Engineers, dealing respectively with the codification of safety rules for the construction of steam boilers and unfired pressure vessels, and the rules for testing boilers, turbines, engines, and other power equipment. In 1888 Mr. Low was appointed fifth editor of *Power*, which had been founded four years earlier, to serve the needs of power engineers in the operating field. Under his leadership as editor, which extended to 1930, the field of the magazine was broadened, without changing its practical approach, to serve also the needs of professionally trained power engineers, designers, and consultants. In 1930, at the age of seventy, he became editor emeritus of *Power*.

Mr. Fred Low's career was outstanding as much for his personality and friendships as for his achievements in engineering and journalism. In his rise he never lost touch with the practical engine-room men of his early days. He was noted for his friendliness, his simple directness and practicality in speech and writing, and his rich fund of humour.

SIXTY YEARS AGO.

"THREE children sliding on the ice, Upon a summer's day. As it fell out, they all fell in, The rest they ran away. Now had these children been at home, Or sliding on dry ground, Ten thousand pounds to one penny, They had not all been drown'd." This little ballad started life in the seventeenth century as a nursery rhyme. Long afterwards a ponderous joker, Professor Porson, translated it into Greek and published it as a fragment of an old Greek play. For a time the imposition succeeded and was held in some quarters to prove that the ancients were acquainted with the art of skating on ice. In our issue of February 4th, 1876, we recalled the rhyme and pointed out that the possibility of skating upon ice on a summer's day had recently been brought within the domain of actual fact by Mr. Gamgee who, following the lead given in 1865 by Mr. A. W. Parker, had devised freezing apparatus by means of which large sheets of ice or "glacaria" could be created even under the most unfavourable atmospheric conditions. The rhyme was also topical in its reference to sliding on dry ground, for roller skating was at that date—1876—enjoying its first burst of popularity. The history of the roller skate does not however appear to extend beyond the year 1819 when a Frenchman, Petitbled, invented a device, described as a roller skate, the details of which have not survived. The next invention was that of Mr. Tyers, a Piccadilly fruiterer, who in 1823 patented a roller skate, or "volito" as he called it, consisting of a stock or frame carrying beneath it five or six rollers arranged in a single longitudinal row. A feature of the invention was that the lowest points of the rollers were set to touch not a straight line but the arc of a circle. Garcin, a Frenchman, in 1828, patented a roller skate called a "cingar" consisting of a stock with three rollers arranged in a single row and provided with side irons to be strapped to the leg. Gidman in 1852 devised a skate with four rollers one in front, one behind and two, side by side, at the middle. The wheel axles were mounted on anti-friction bearings. In 1860 an American, Shaler, invented a four-roller, single-row skate with the rollers fitted with rubber tires. Another American, Pennie, in 1861 produced a skate with eight rollers arranged in four side-by-side pairs. The skate was made in such a way that after experience had been gained the user could convert it to a four-wheel single-row skate. A two-wheeled "penny-farthing" type of skate was devised in the same year by yet another American, Anderson, and in 1865 Gregg, another representative of the same inventive nation, patented a skate with four wheels, a small forward and a small rear roller and two large side-by-side wheels at the centre. All these early skates suffered from a common defect. The axles of the various wheels were always parallel with one another. The skater might be able to progress easily enough in a straight line but to execute a turn required something of the skill of an acrobat. This defect provided Mr. Plimpton, yet another American, with an opportunity for making his name famous. In 1863 he produced a skate supported on two pairs of side-by-side rollers each pair being mounted on a carriage attached to the stock in such a manner as to permit the wheels to "turn or cramp like the wheels of a wagon and facilitate the turning of the skate." He developed the idea in subsequent years until he produced a form of roller skate which has since become almost standardised. By an ingenious arrangement he caused the tracking of the wheels to become effective only when the stock was canted to one side or the other. He was not without his imitators. In 1876 he brought an action in the English Courts against Mr. Malcolmson of Brighton for infringement of his patent rights. The defendant pleaded invalidity by virtue of prior publication. After a hearing which lasted six days the Master of the Rolls found for Plimpton on all issues.

THE SOUTHERN RAILWAY VALUATION.

IN 1929 the railway companies were derated conditionally on any reductions being passed on to the heavy trades—coal, iron, and steel. That brought to a head the need for a valuation of all the railways on a basis of net receipts, divided out among the areas concerned. The Act of 1930 followed, which set up a Railway Assessment Authority, which was to revalue the whole of the railways on this plan. The first of these new valuations was completed in December, 1934, and it revealed, to the railway company, the quite unexpected result that, instead of effecting a reduction the new valuation was much higher than the old. The Southern assessed their own valuation at £500,000, but the Railway Assessment Authority, by a different measure of what was profit, put it at £2,180,000. The railway company thereupon appealed to the Railway and Canal Commission, who reversed the decision of the Authority and reduced the assessment to £1,077,131. The latter body then, with the support of such interested parties as the London County Council and the Brighton Corporation, appealed to the House of Lords, who, on Friday, the 24th, supported the Railway and Canal Commission and the Southern Railway. The other railway companies were also indirectly assisted, as, by agreement, their valuations were not adjudicated upon until the Southern was disposed of. The result is that some £15,000,000 will have to be refunded to the railways, of which one-quarter will be due from local authorities. The other three-quarters will be due from the Railway Rebates Fund, who will find themselves in a quandary, as they have already paid out the money in helping traders, but it cannot be recovered from so wide a field.

COMPARATIVE ROAD AND RAIL COSTS.

THE following passages are taken from a paper on "Modern Methods of Permanent Way Maintenance," by Mr. J. C. L. Train, read at a meeting of the Institute of Transport on January 13th :—

I was hopeful that it might be possible to make some comparison between road and rail costs in relation to the traffic passing over each of them. I have studied the Ministry of Transport Report on the Administration of the Road Fund for the years 1933/34, but I am unable to find therein figures comparable with those which are available in respect of railways. If there are such figures, I would be interested to hear them put forward, although, personally, I have not had access to them.

In the case of railways, a clear distinction is drawn between maintenance and renewal costs, but I am not certain how far this is so in the case of roads. In the Report mentioned, the maintenance, repair, and minor improvement of Class 1 roads is given as £445 per mile, or £347 per mile in the case of Class 2 roads. If this figure can be regarded as maintenance, then it is considerably more than the cost of repairs and partial renewals of the main group railways, which amounts to about £130 per mile of single track per annum.

Taking renewal of way, we know that in this country the cost of complete renewal of track with modern materials, including switch and crossing work, comes out at somewhere about £2200 per mile for wages, materials, engine power, &c.

I gather from district reports embodied in the before-mentioned Ministry of Transport Report that the cost of resurfacing classified roads works out at about £5000 per mile. To carry the comparison further, it would be necessary to know the life of the new material, and although we have a fairly accurate idea in the case of railways what is the life of new materials—say, out in the country, it may be as much as twenty-five years—I do not know whether it is possible to put any such life on highway surfaces.

Lastly, in the case of railways, we can readily ascertain the ton-miles passing over any particular length of track; but, again, I think this is not available in the case of roads.

Summing up what is stated above, I would like to have looked at the matter from a national point of view; in other words, I suggest that there are no figures available to disprove the statement that it is uneconomical, even with pneumatic tires, to haul heavy loads over roads having regard to the life of road surfaces. We know very well the cost of new road construction in this country, but I doubt whether we yet know what increased maintenance cost will result from such new construction under modern road traffic.

Rail and Road.

PURPLE crepe was draped during the days of mourning on the L.M.S. engine "Silver Jubilee." The selection of that locomotive was appropriate, as its name was given by King George's permission last year in commemoration of the King's Jubilee.

His late Majesty King George paid two visits to railway works during his reign One was in May, 1913, when he visited Crewe Works. The other was to Swindon Works in April, 1924, when he rode on the footplate of the engine, that was to draw his special train, on its way from the Swindon shed to the station.

A NEW form of control for street traffic signals, devised by the Automatic Electric Company, is being tested in Piccadilly. It is, in a sense, a warning arrangement, such that the deflection of a detector pad at a crossing sends a warning of the approach of vehicles to the next detector pad in advance so that the approach of a second flow of traffic is anticipated. The arrangement is in use in Glasgow and it is claimed that traffic is dealt with more easily.

THE Ministry of Transport railway statistics for October show that, compared with the corresponding month of 1934, there was an increase of 4·0 per cent. and that the receipts rose by 2·3 per cent. The tonnage of freight increased by 7·8 per cent. and the freight receipts by 3·4 per cent. The freight train mileage advanced by 1·8 per cent.; the average train load increased from 123½ to 129½ tons, and the net ton-miles per engine-hour from 457¾ to 471½.

A PLAN of the proposed tube railway in Manchester, published in the *Manchester Guardian* of January 10th, shows that it is proposed to start it on the east side of Victoria Station and run to London-road Station, with an intermediate station at Shudehill and Piccadilly, and thence to Oxford-road, the Central Station, and Ordsall-lane, with an intermediate station between the two last-named. At Ordsall-lane there will be a junction for a separate line to Exchange Station.

AUTOMATIC signals of the colour-light type are to be provided by the L.M.S. Company between Carlton-road Junction, half a mile north of Kentish Town, and Finchley-road, a distance of 1 mile 42 chains. The main feature in this territory is the two parallel Belsize Tunnels, the older one of which is just under a mile in length, whilst the other is 1 mile 62 yards long. The two stations that control the tunnels are Haverstock Hill, at the east end, and Finchley-road, at the west end, and as there is no signal-box between those stations the automatic signals will greatly increase the carrying capacity of all four running lines. The signals are to be of the multiple-aspect type, which increases the number of automatic signals, whilst the greater distance that the signals can be seen assists the driver in the train running.

ON Tuesday, January 21st, a down goods train, when running between Sileby and Barrow-on-Soar, on the Trent and Leicester section of the L.M.S., became separated, and before this was discovered a following train ran into the detached portion and the guard of the latter was killed. The inquest in that case stands adjourned until Thursday, February 6th. Since we recorded on January 24th the disaster of January 19th to a ballast train at Barkston, L.N.E., and the deaths of six of the occupants of the brake van, two further of the unfortunate men have died from their injuries. The inquest was opened on the 21st and adjourned until Monday, February 17th. The coroner's jury in the Shrivenham accident returned a verdict of "accidental death" at the adjourned inquest on January 22nd, and expressed the opinion that there was nothing to prove negligence on the part of any of the servants of the railway company.

THE most important of the schemes to be carried out by the London, Midland and Scottish Railway under the loan guarantee of the Government—Railways (Agreement) Act, 1935—is the rebuilding of Euston Station, including the hotel and offices. Many of the existing buildings were erected nearly a century ago to the designs of Hardwicke, and the reconstruction of the station will involve a complete demolition of all buildings between the station and Euston-road, and rebuilding within those limits. In view of the importance of the work, the directors have appointed Mr. Percy Thomas, the new President of the Royal Institute of British Architects, as consulting architect, to co-operate with the company's architect, M. W. H. Hamlyn, F.R.I.B.A., and the chief civil engineer, Mr. W. K. Wallace, in the preparation of plans and designs for the whole of the buildings embraced in the scheme, including the railway station, hotel, and offices for the company's staff.

THE first fatal passenger train accident on the Great Western Railway occurred within six years of the opening in 1835. It was a derailment in Sonning Cutting and nine passengers were killed. The next worse accident happened, strange to relate at this time, on May 10th, 1848, at Shrivenham. Despite that the signal was "off" for an up express, the station staff opened the siding points and admitted two vehicles on to the up main line. Six passengers were killed. Those two accidents and one at Wolverton on June 5th, 1847, and another at Bicester on September 8th, 1851, each of which was caused by trains being incorrectly turned into sidings and in which seven and six respectively were killed, were the worst accidents on the railways of the United Kingdom until the fifteen killed in the collision of October 5th, 1853, at Strafford, on the Great Southern and Western of Ireland. The Great Western can present a far better record for the present period. Since the opening of the present century there has been only one accident in which more than one passenger lost his life. That was at Yeovil, with three killed, on August 8th, 1913; other accidents since then were Warminster, September 2nd, 1916, and New Tredegar, October 9th, 1928. At Shrivenham, on January 14th, again only one passenger was killed, but unfortunately there was also one servant who succumbed to his injuries.

Miscellanea.

AN oil refining plant with an annual refining capacity of some 300,000 tons of raw oil is being erected near Trieste.

To celebrate the centenary of the death of Ampère, an historical electrical exhibition will be held in Lyons from March to June next.

DURING 1935 machinery imported was valued at £13,144,004, whilst machinery to the value of £38,495,459 was exported from this country.

A COMPILATION of letter symbols and abbreviations in use by engineers and scientists is to be undertaken by the Committee on Symbols and Abbreviations of the American Standards Association.

THE accommodation of the British Cotton Research Association's station will be considerably increased when the extensions to the Shirley Institute at Manchester are opened on March 25th next.

SANCTION has been given for the construction of a large new power station to be constructed at the Chitera Falls in the Muzaffarnagar district of Northern India. Preliminary construction work has begun.

A BRITISH Chemical Plant Exhibition will be held in the Central Hall, Westminster, from June 22nd to June 27th next, in connection with the International Chemical Engineering Congress of the World Power Conference.

ON Thursday next the Minister of Transport is to receive a joint deputation from Tynemouth and South Shields Corporations on the proposed tunnel under the Tyne between the two boroughs. The estimated cost of the tunnel is £1,300,000.

WHAT is believed to be the largest arc-welded bridge of its kind has been constructed on the new international toll highway connecting Cornwall, Ontario, with Roosevelttown, New York, U.S.A. It consists of two 150ft. through-truss spans and a 40ft. rolled beam approach span at either end.

A NEW association, to be known as the Association of Road Traffic Sign Makers, has been formed, its main object being to constitute, provide, and maintain a central national organisation for the support, protection, and furtherance of the interests of manufacturers and suppliers of road traffic signs and devices.

THE Royal Commission on Safety in Coal Mines, under the chairmanship of Lord Rockley, recently met in order to discuss matters of procedure. It was agreed to hear witnesses in public, and to hold the first public meeting on February 10th, when Sir Alfred Faulkner will give evidence on behalf of the Mines Department.

A CONFERENCE for the discussion of soil mechanics and foundation engineering will be held in the United States by the International Conference on Soil Mechanics and Foundation Engineering at Harvard University, Cambridge, Mass., from June 22nd to 26th, 1936. The primary purpose is to make available detailed existing information which is of value to the soil engineer, but which for various reasons has remained unpublished or unavailable, and to provide for better co-ordination of future work.

THE annual report, for the financial year ended March 1935, on the administration of the Road Fund, has, for the first time, some comments on the road accidents investigated by the divisional road engineers. There were 837 such investigations. Contributory causes assigned were: slippery road surface and worn setts, &c., 425; blind corners of all kinds and bad visibility, both horizontal and vertical, 154; tramway tracks, pavings, &c., 112; defective shape of carriageway, excessive camber, lack of superelevation, &c., 48; street lighting inadequate or absent, 45. Representations were made in 386 cases.

THE use of chlorinated rubber compositions as protective agents for iron and steel work was discussed by Dr. Schultze, of Ludwigshafen, before a recent symposium held in Berlin by the Verein Deutscher Chemiker. The extract of the discussion in the *Chemical Trade Journal* says that the surface to be treated should be carefully freed from rust, fat, and moisture. The softening agents employed in the rubber composition should preferentially be unsaponifiable. The pigment content of the varnish should not be too high, and never above 50 per cent. of the weight of the total binding agent. The pigment should be of as fine particle size as possible, and for the most efficient protection several coats should be given. Chlorinated rubber protective compositions should not be expected to function at temperatures above 60 deg. Cent. Their use to-day is spreading rapidly to aluminium, its alloys, and to other materials. These new paints are also being employed successfully with concrete, masonry, and wood. Costs are higher than those of the usual protective agents, but the results are better and the life of the coating considerably longer.

A SOMEWHAT unusual method of boring 5ft. diameter holes for the concrete foundation shafts for the spillway gate of the Fort Peck Dam in the United States. The ground is of shale formation and, according to the *Engineering News-Record*, the cutting is done with augers made on the site. The cutting device is a split circular pan, 5ft. in diameter, fitted with two sets of cutting teeth. The pan is mounted on the lower end of a 50ft. pipe shaft; at the upper end of the shaft is a 40 h.p. electric motor and reduction gear assembly from a 75 h.p. tractor. A coating of tungsten carbide has been welded to the cutting teeth to resist wear. The auger assembly hangs from the load line of a long-boom crawler crane. A telescopic pipe arm extending from the gear-box to a lower corner of the boom resists the torque of rotation. In operation, the cutter is lowered to the bottom of the hole before rotation starts. After a foot or more depth is drilled the rotating power is shut off and the whole assembly is lifted by the crane, the excavated spoil being brought up on the cutting pans. When clear of the ground the auger is swung to one side for dumping. About 4ft. above the pan the drive shaft is hinged. To dump the load a locking pin on the hinge is pulled and a line is hooked around the teeth of the cutter, which pulls the pan to a vertical position and dumps the load. Unhooking the dump line and replacing the locking pin prepares the auger for another digging cycle. The digging rate is about 5ft. per hour.

Air and Water.

THE "Normandie" will recommence her Atlantic service on April 15th next, and not in March as previously announced.

THE crew of thirty-four of the steamship "Forthbridge," which caught fire 25 miles from Okinoshima Island, have all been rescued.

DUTCH shipyards are reported to have secured an order for two submarines to be built for the Polish Navy, at a cost of some £700,000.

THE death is announced of Mr. F. H. Houlder, who was for many years chairman and managing director of Houlder Brothers and Co., Ltd.

THE Air Ministry has issued a notice that the boundary lights at Croydon airport from January 31st will be fixed in character, instead of simultaneously occulting as at present.

THE American lightship on the Nantucket Shoals recently broke her moorings during a heavy storm and was adrift for twenty-eight hours before being returned to her anchorage.

IT was stated at the annual meeting of the Manx Season Extension Committee that an air race from England to the Isle of Man and a Manx air "Derby" is being arranged for this year.

THE first of the eight new torpedo-boat destroyers of the "Hero" class, H.M.S. "Hostile," has been launched at Greenock. These vessels have a displacement of 1350 tons, and a designed speed of over 35 knots.

THERE was a drop of 279,000 tons in the bunker coal trade of the Tyne during 1935. During the same period 204 vessels took 31,012 tons of fuel oil, as compared with 134 vessels and 17,069 tons the previous year.

IT is announced that the French Director of Civil Aviation has authorised the use of Querqueville aerodrome as a Customs airport. Hitherto foreign aircraft bound for Cherbourg have had to land elsewhere to clear Customs.

IT is announced that the Farman F 224 forty-passenger aeroplane, being built for Air France, is to be provided with ten openings in the fuselage to facilitate the exit of passengers by parachute in emergency. The parachutes will be carried in the backs of the seats.

AT a recent meeting of the Civil Aviation Section of the London Chamber of Commerce, Mr. H. N. St. V. Norman was elected Chairman for the year 1936 in succession to Viscount Ratendone, whilst Air Vice-Marshal A. E. Borton was elected as Deputy Chairman.

DURING a thick fog on Saturday night last three vessels went ashore off the Yorkshire coast. Two of the ships, the "Heatherfield" (447 tons) and the Icelandic trawler "Andri" (316 tons), grounded near Whitby, and the steamer "Greyfriars" (1142 tons) went on the rocks near Flamborough Head.

ACCORDING to statistics issued by the Cunard White Star Line during 1935, the company's ships carried 158,091 passengers. Of this total, 18,232 passengers sailed on cruises to the Mediterranean, the West Indies, Bermuda, &c. A total of 70,068 passengers were carried to Europe and 69,791 from Europe.

THE trial which followed the loss of the liner "Morro Castle" by fire off the New Jersey coast in September, 1934, when 124 lives were lost, has resulted in the owners of the vessel, Henry Cabaud (vice-president of the company), Acting-Captain William Warms, and the chief engineer, Eben Abbott, being found guilty of criminal negligence.

THE latest form of steam propulsion machinery is installed in the Booth Steamship Company's new liner ss. "Anselm," which is now on her maiden voyage to Brazilian ports. The main machinery comprises a three-cylinder geared turbine set, with underslung condenser, taking steam from three Howden-Johnson boilers, working at a pressure of 250 lb. per square inch.

IT is announced that negotiations are to be resumed between the Tyne Improvement Commission and the London and North-Eastern Railway concerning a proposal whereby the port authority is to acquire the railway company's Tyne Dock and construct new deep-water quays. Negotiations took place last year, but fell through owing to the big difference in the price required and that offered by the Commissioners.

VESSELS to and from British ports during 1935 aggregated 349,577,851 net register tons, an increase of 1·1 per cent. on 1934. The figures for the Port of London, at 59,762,434 net register tons, are the highest ever recorded, and constitute a record for British ports. Figures for the other chief ports in net register tons are as follows:—Liverpool, 33,238,099; Southampton, 25,004,035; Hull, 12,115,428; Manchester, 7,573,304; Bristol, 7,091,650.

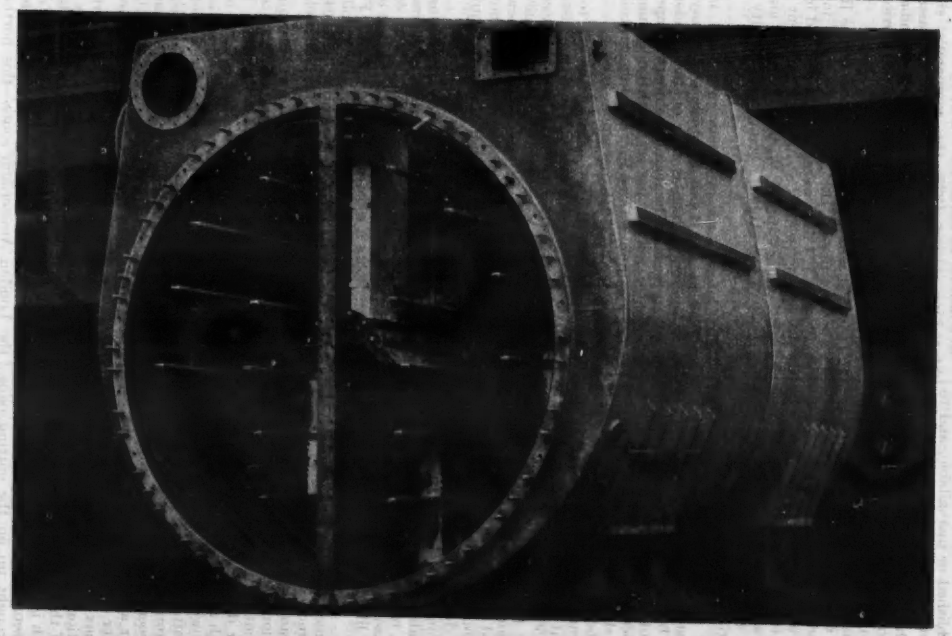
THE Lloyd's Register figures for the last quarter give the Clyde a total of fifty-six vessels, of 317,500 tons, on hand; the total is, however, considerably greater. Excluding the naval contracts, which are not included in the returns and the fitting-out work, which is, there are more than seventy vessels of merchant type on the stocks or on order from Clyde firms. The tonnage, says *Shipbuilding and Shipping Record*, will not be any greater than given in the official figures, as the 73,000 tons of the "Queen Mary" will about balance the tonnage of the work to be laid down.

THE first direct air service from the North of England to the Continent to be operated regularly by a British firm is announced for next summer by British Continental Airways, says *Flight*. Pursuing the policy of close co-operation with K.L.M.—a co-operation which already exists on the London–Amsterdam route—this northern route will be operated daily by the two companies, which will run alternate services. The route will not be exactly the same as that flown for the last two summers by K.L.M. Next summer the line from Liverpool will be *viâ* Doncaster, which is not only more direct, but also takes advantage of the fact that Doncaster may be described as a railway centre of the Yorkshire manufacturing districts, and thus gives the maximum facilities for passengers and freight.

105,000-KW TURBO-GENERATOR AT BATTERSEA—CONDENSERS AND ALTERNATORS

METROPOLITAN-VICKERS ELECTRICAL COMPANY, LTD., MANCHESTER, ENGINEERS

(*For description see page 129.*)



CONDENSER SHELL

CONDENSERS AND MOTOR DRIVEN PUMPS

YOKE OF MAIN ALTERNATOR

ALTERNATOR ROTOR

The Engineer

JANUARY 31, 1936.

VOL. CLXI. No. 4177

Contents.

THE ENGINEER, January 31st, 1936.

	PAGE
A SEVEN-DAY JOURNAL	115
AMERICAN BEACH AND SHORE PROTECTION WORKS. No. III. (Illus.)	116
THE DUMBARTON VALVE WORKS OF BABCOCK AND WILCOX, LTD. No. I. (Illus.)	119
THE DECAY OF WOOD	121
EXHAUST STEAM TURBINES FOR MARINE PROPULSION. (Illus.)	122
OBITUARY—	
Fred R. Low	124
SIXTY YEARS AGO	124
THE SOUTHERN RAILWAY VALUATION	124
COMPARATIVE ROAD AND RAIL COSTS	124
RAIL AND ROAD	125
MISCELLANEA	125
AIR AND WATER	125
LEADING ARTICLES—	
The Steel Trade	127
Incentives	127
INSTITUTION OF MECHANICAL ENGINEERS	128
LETTERS TO THE EDITOR—	
Flood Prevention Schemes	128
The Locomotive "Bedlington"	128
BOOKS RECEIVED	128
105,000 kW TURBO-GENERATOR FOR BATTERSEA. No. II. (Illus.)	129
WATT BICENTENARY EXHIBITION. (Illus.)	132
THE CANTIENY HIGH-PRESSURE BOILER. (Illus.)	133
A.C. PUSH BUTTON STARTERS. (Illus.)	133
A BATCH TRANSFERRING MACHINE. (Illus.)	134
A LARGE LATEX DRYING MACHINE. (Illus.)	134
A THREE-WHEELED FACTORY TRACTOR. (Illus.)	134
BRITISH STANDARDS INSTITUTION	134
ECHO-SOUNDING EQUIPMENT FOR SHIPS. (Illus.)	135
PERSONAL AND BUSINESS ANNOUNCEMENTS	136
CONTRACTS AND ORDERS	136
AMERICAN ENGINEERING NEWS	136
LAUNCHES AND TRIAL TRIPS	136
MARKETS, NOTES AND NEWS	137
CURRENT PRICES FOR METALS AND FUELS	138
FRENCH ENGINEERING NOTES	139
BRITISH PATENT SPECIFICATIONS. (Illus.)	139
FORTHCOMING ENGAGEMENTS	140

NOTICES TO READERS.

*** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

CHANGES OF ADDRESS.

*** *Will subscribers please note that in al advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

THE STEEL TRADE.

THE rapid recovery of the steel industry from the throes of depression is one of the outstanding features of the industrial revival which we are assured we have entered, and naturally enough has aroused academic as well as professional interest. The salient facts are that from the low production of 5,202,600 tons in 1931, the industry achieved the record output of 9,842,400 tons in 1935; that during that period it was favoured with a manipulated customs tariff, has nearly completed a wide-reaching scheme of reorganisation, and allied itself with the Continental Steel Cartel. Opinions differ as to which of these has been the most effective factor in producing the conditions which made record outputs possible, and are often coloured by the political bias of the individual. It must be admitted, however, that whilst each of these events played a part in restoring prosperity to the industry, the reorganisation could not have been carried out so completely, or entry into the Cartel obtained on such advantageous terms without the protection afforded by the customs duties. It was the high tariff that kept out Continental steel and enabled a bargain to be struck with the Cartel which for nine months of last year forced consumers to reply on supplies of British material to a greater extent than ever before. The fact that the imports were rationed amongst consumers, and that the steel was released only by agreement with the British steel makers in irregular quantities without notice and at indeterminate periods, increased the dependence of the users upon the British steel makers. The view that the growing demand for steel is almost entirely based upon the housing boom must be accepted with reserve. Whilst making due allowance for the quantities of materials absorbed in general building, in the erection of new works and in works extensions, it is probable that the many Government and municipal public works undertakings which were proceeded with in 1934 and the Government schemes for aiding sections of industries, were the principal factors in creating the phenomenal demand for steel. Following the political crisis of 1931, public expenditure was severely curtailed, and it was not until last year that the curb was definitely relaxed and public bodies were able to proceed with many programmes which had been held in abeyance.

The reorganisation of the industry has played no part in developing the demand for steel, but it has enabled the steel makers to break down to a great extent the custom of making concessions on attractive orders, and in this way to raise their average selling prices. This, combined with the record production, has put the industry in the strongest position it has occupied since the years immediately following the war. It is faced, however, with problems not unlike those which confronted it at that time, and which were then far from successfully handled. To all the principal consuming industries—engineering, building, the motor trade, shipbuilding—the question of prices is of vital significance. For two or three months now there has been persistent agitation on the part of influential interests in the steel industry to raise selling prices in the home market. The authorities have been able to restrain this movement so far as structural steel is concerned, but there have been sharp increases in the price of other descriptions which are in common use. The general belief is that now the coal dispute has been settled by a advance in the miners' wages, an upward movement in steel prices will not be long delayed. Unquestionably, there has been a rise in the cost of many raw materials, including scrap, and on these grounds a good case could be made out for an advance; but the extent of such a movement should be closely scrutinised. The lessons of the past cannot be ignored, and it should be remembered that one of the contributory causes of the collapse of the post-war boom in the steel trade was the adoption by the steel makers of a selling policy which permitted excessive prices to be charged, and there is no doubt that the consuming industries to-day are not without anxiety upon this score. Turning to the export side of the steel trade, it has yet to be proved that the national interest was best served by the agreement with the Cartel which limited the overseas trade in steel to the proportion which the British exports in 1934 bore to those of the Cartel countries. It was admitted at the time that the British share was very low, but it was claimed that the acceptance of these terms gave some compensation to the Continental steel makers for the drastic reduction of imports into this country. Yet so badly did the British steel makers miscalculate their ability to meet the home trade demand that it has been necessary to import a large tonnage in excess of the Continental quota, and it has still to be seen if a *quid pro quo* will be given by the Continent in the export market.

The steel makers are riding upon the crest of a wave of prosperity, and it is to be hoped that they will adopt a policy of live and let live in their relations with other branches of the trade. But the establishment of the British Iron and Steel Corporation, in which it is difficult to see any other object than an intention to supplant merchant firms in the distribution of steel and to secure a monopoly of the sale of Continental imports, is not calculated to inspire confidence in the new regime. The Import Duties Advisory Committee, in recommending the duties, professed to be alive to the danger of exploitation, having in mind apparently the possibility of an unwarranted advance in prices, but it is now being realised in many quarters that exploitation may take other forms than price inflation. At the moment, however, it would seem that the steel makers are imbued with a desire to establish their industry in a position which has little regard to other interests. It has been the good fortune of the industry that it has been able to carry out reorganisation during a period of progressive trade expansion. The real test of the structure it has built will come when the boom has spent itself, and when works are struggling to obtain orders instead of being in a position to scrutinise proffered business. There are not lacking signs that the dictatorial tone of the Steel Cartel is arousing resentment. The attitude of the Belgian Government, for instance, toward proposals which would place the merchant firms of that country at the mercy of the Cartel has not been exactly sympathetic. On the other hand, the South African steel industry, which has hitherto had a somewhat chequered career, has startled the British and Continental makers by proposing to apply to South African imports a policy similar to that which the British found successful against Continental imports. In other directions also there are indications that the lessons to be learnt from the Cartel methods and the reorganisation of the British industry have not been disregarded by the smaller steel industries of the world. These tendencies point to a continued restriction of overseas business in steel, and whilst it may be that the British steel makers would be satisfied with a small regulated export trade at high prices, we venture to think that their contentment can only last so long as the home market can absorb their production.

Incentives.

IT would be of great interest to the taxpayer to know how many works owners and managers are influenced by, or even read, the reports issued by the Industrial Health Board of the Medical Research Council. It would be of further interest to know what these publications cost the State, and what part of the cost is recovered by sales. Let it be admitted that on certain subjects which do directly concern the health of workers—poisonous fumes and dust, air and lighting, for examples—inquiries carried out by the officers and inspectors of the Medical Research Council may prove valuable where the drafting of new regulations is concerned. But when these subjects are departed from and when the Industrial Health Research Board turns its attention to questions with which the works manager and his foremen are quite conversant, it is impossible not to feel that its activities should be justified before they are pursued. No doubt, it will be claimed by the enthusiasts and salarians of the psychological order of research that they are the pioneers of a new science, and that a tolerant patience must be shown if their efforts are not of obvious value to the existing generation. We listen to that plea, but can feel no sympathy with it when, as often happens, we observe that the conclusions reached are as old as industry itself and that the research workers achieve little more than the expression of them in formal "psychological" language which must repel the very persons who ought to be most interested.

We have discussed some reports of this kind on former occasions, and one lies before us now, the latest emanation of the Industrial Health Board, which calls out for critical examination. It is entitled "Incentives, some Experimental Studies," and was written by Mr. C. A. Mace, who conducted the experiments described in it in the Psychological Laboratory of St. Andrews University. Why anyone should want to study industrial incentives at all, and particularly why they should want to study them in a "laboratory," it is difficult indeed to say. It looks uncommonly like "Science for Science sake." It is as though the research worker had said: "It is quite true that this question has been answered by common sense time out of mind: but the truth is not in us until we have confirmed it by scientific tests under laboratory conditions." The report fills no less than 62 pages of the familiar size. Six of those pages are occupied by an Introduction which might have been adequately compressed into a fraction of its length. However, we leave it, and turn to the end of the pamphlet where the Test Operation is described in detail. It consists of two parts—a Complex-Computation test and a Manual test with a toy called a "Ball and Slot Board." For the former foolscap sheets of paper with four vertical rows of figures are employed. The subjects of the research are told that on the word "Go" they are to do specified simple sums of multiplication and addition with these figures. Scores are kept of the number of operations correctly performed in a period of ten minutes. The Ball and Slot test is made with a board placed more or less vertically. On the lower half are brass strips dividing the width into twelve channels, each of which is numbered. At the side near the top of the board is a little platform. Through an aperture the subject inserts a small steel ball on to this platform, and by a simple sharp movement endeavours to project it into a prescribed slot. A test period consists of ten to forty sets of ten shots each. Is it with such parlour games as these that the psychologist in the laboratory hopes to teach the employer the value of industrial incentives or to discover facts which were not known ages before Greek youths ran for laurel wreaths? Some of the tests were carried out with eighty-eight university students and some with thirty-four children. The incentives do not appear to have been of material or even gustatory value. We shall not expend time on an examination of the "principles" derived from such tests, but must quote one example of the form in which they are expressed. It runs: "The rate of progress in acquiring specialised

ability depends not only upon the intensity of effort directed to the general objective, but also upon the specific manner in which the objective is defined, *i.e.*, upon the nature of the standard prescribed or adopted." The pleasure which we derive from this Principle is marred by the fact that we are not able to witness the reactions of works managers to it!

It would be unprofitable to give more space to this Report, and indeed we have not the patience to do so. There is an unreality about such tests with students and children that alienates the sympathy of practical people. Useless as many psychological tests carried out in factories may be, they are by contrast with this "laboratory" research of unbounded value. There is a recognised principle in the physical tests of the strength and endurance of engineering materials that the conditions of service should be simulated. We commend it to the consideration of those who conduct psychological laboratories, particularly if they happen to be the servants of the State, and supported by the taxpayers. We said in our opening lines that it would be of interest to know what attention works owners and managers pay to these academic researches. With full seriousness, we say now that a proper detailed and independent inquiry should be made, and that unless it is found beyond dispute that work of the kind is of immediate or potential industrial value, further expenditure upon it should be stopped. The taxpayer may very justly require that his money shall not be expended on unprofitable work, whatever aura of "science" may envelop it.

Institution of Mechanical Engineers

A PAPER, entitled "Exhaust Steam Turbines for Marine Propulsion, with Special Reference to the Rowan-Götaverken System," was presented by Dr. J.-B. O. Sneeden before the Institution of Mechanical Engineers in London on Friday evening of last week, January 24th. The paper, of which an abstract is printed elsewhere in this issue, was well received but evoked little criticism.

Mr. A. Stevenson, of Messrs. Rowan, stated that within the past two years his firm had completed sixteen sets of Götaverken exhaust turbines and had received orders for an additional eight sets. Among the advantages of the system which deserved particular emphasis were its small size, its self-contained nature, the absence of mechanical connection with the main engine and the fact that its installation required no structural alteration in the hull or at the most the formation of only a small recess. The changes involved in passing from ahead to astern motion were effected automatically and if the turbo-compressor went out of action the main engines continued to run normally.

Mr. H. G. Bauer, of Hamburg, said that during 1935 sixty-seven ships were fitted with Bauer-Wach exhaust turbines of which ships three were converted while the rest were new vessels. One of the advantages claimed for the Götaverken system when applied to existing vessels was its low first cost. The number of ships available for conversion was, however, decreasing rapidly. In any event if the Götaverken system cost less than others it also saved less. According to Dr. Sneeden the saving effected by the Götaverken system was of the order of 16 to 18 per cent. as measured by the heat consumption per indicated horse-power hour, whereas with the systems of the mechanical coupling and the electrical coupling groups the saving was of the order of 22 per cent. or over. The relative lowness of the saving achieved by the Götaverken system might, he thought, be attributed to the complicated process of conversion through which the energy in the exhaust steam was passed before it was usefully applied to the propulsion of the ship. The heat energy in the exhaust was first converted into mechanical energy in the compressor, restored as heat and pressure energy to the exhaust from the high-pressure cylinder of the main engines and finally applied as mechanical energy to the propeller shaft.

Mr. J. Johansson, of the Götaverken Company, having said a few words, Mr. P. L. Jones, of Swan, Hunter and Wigham Richardson, remarked that the Parsons system under which the exhaust turbine was allowed to run idly in the condenser vacuum during manœuvring was likely to place a heavy drag on the main engines. Under similar circumstances the hydraulic coupling inserted in the Bauer-Wach system between the exhaust turbine and the propeller shaft permitted the turbine to be cut out when the main engines were reversed. He noted that, according to the author, the additional propelling machinery in the Metropolitan-Vickers electrical coupling system reversed with the main engines during manœuvring. He believed, however, that in the latest examples power was automatically cut off from the exhaust turbine when the main engines were reversed. That being so, it was a little difficult to see, if reversing were not possible, what advantage accrued from the arrangement made in some cases to admit live steam to the exhaust turbine in the event of the breakdown of the main engines. He criticised the author's statement to the effect that in the electrical coupling group the overall efficiency from turbine shaft to propeller shaft would be about 92 per cent. Allowing for the efficiency of the reduction gearing such an overall figure would imply an efficiency of about 97 per cent. in the generators and motors. Passing to the heat coupling group he said it was not clear why in the Lindholmen system the surplus electrical energy was not available for superheating the working steam if the boiler steam were already superheated by 100 deg. Fah. or more.

Major W. Gregson suggested that instead of taking as the basis of comparison the heat consumption per i.h.p. hour it would be more satisfactory to use b.h.p. or s.h.p. hours. He also contended that the heat consumed per hour by the auxiliaries ought to be included in the bill and not excluded as Dr. Sneeden argued it should be. In examining published figures for the savings effected by different systems for the utilisation of the energy of the exhaust steam he had been struck by the considerably different figures sometimes presented by one and the same system. That variation, he thought, was to be ascribed to the fact that in some instances the ships to which the figures related were new and had modern engines while in others the exhaust steam equipment had been added by way of conversion to existing ships with very inefficient engines. Dr. Sneeden's figures were satisfactory in that respect for they were all reduced to a common basis of comparison, a modern ship with triple-expansion engines of about 1620 i.h.p. The paper, he thought, raised by implication a very important question: What was the best type of engine—oil, turbine or reciprocating—for tramp vessels of 1000 to 2500 horse-power; that was to say, for a class of ship with which a very large proportion of our trade was conducted. That was a subject, he contended, of national importance and might well be studied by a joint Institutional Committee analogous to the Marine Oil Engine Trials Committee.

Mr. A. Page presented the meeting with the results of a prolonged theoretical study which he had made on various methods of improving the steam cycle in engines. The range of his studies embraced sundry cycles involving steam compression and one originated by Professor Koeneman in which pressure transformation was effected by blowing low-pressure steam into a vessel containing a solution of caustic potash, the heat of solution being used to generate high-pressure steam in an adjoining vessel. He exhibited a drawing of a KOH steam generator including equipment for preserving the caustic soda solution at a given degree of concentration and suggested that chemical recompression might be tried as an alternative to mechanical recompression for marine work.

Mr. H. L. Guy expressed his admiration for the ingenuity and originality displayed in the Götaverken system. The trial results given in the paper were, he thought, open to some correction to allow for variation in the barometric pressure. He agreed with the author regarding the omission of the heat consumption of the auxiliaries which on a strictly comparable basis ought to be taken as being the same for all the systems investigated. Similarly the feed system adopted in the Götaverken system ought not to be counted as contributing to the saving effected for it could be equally well adapted to any of the other systems.

In his reply to the discussion Dr. Sneeden emphasised the difficulty of comparing the results claimed for the various systems now in use for utilising the energy of the exhaust steam from marine reciprocating engines. It was hardly possible to obtain figures covering similar conditions. If really comparable data were required for the savings effected the only way of obtaining them was, as he had done in his paper, to select a practical modern triple-expansion engine as a basis of comparison. He was glad to learn that Mr. Page did not advance his ideas as a serious proposition.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

FLOOD PREVENTION SCHEMES.

SIR,—Whatever individual opinion may be entertained on the merits of the distribution of centrally generated power in the hands of the State, with its social and political implications at the expense of military security and individual independence, the grid is with us for good or ill and we must make of it what we can.

May I, therefore, in this connection, suggest that it has a use outside its direct distribution of power by providing an equalising medium for the provision of a paying load in certain schemes, thereby making the outlay of heavy capital more practicable by providing a cash return apart from the improvements secured by such schemes.

Amongst those which suggest themselves are flood prevention works involving the construction of large reservoirs equipped with powerful pumping plant which normally might be expected to have a usage factor of no more than 2 per cent. or 3 per cent., but if the plant is laid out alternatively for the generation of current, the demand for which is growing, it should be possible to utilise it for 95 per cent. of its time for such purpose, provided only that the grid reserves are sufficient to take up the load when the prime movers are switched over to their impounding duties for flood prevention.

Whether, on the grounds of simplicity, the prime movers take the form of hydro-gas pumps capable of feeding water turbines and so generating current, or of Diesels capable of mechanical connection with generators direct or alternatively to the pumps direct, is a matter for consideration, the conversion factor being, of course, in favour of the latter system while capital outlay favours the former, but in either case the acid test of its practicability appears to lie in the ability of the grid to furnish the necessary flexibility with its reserves.

It is hardly desirable to go too deeply into figures perhaps in a letter merely suggesting such possibilities, but it can be shown, for example, in the case of the Thames Valley, that reservoir capacity capable of containing one day's full flow of the river at maximum flood in recent experience; that is to say, 10,000 million gallons, and provided with pumping plant capable of impounding 25 per cent. of that volume daily for a period of four successive days, should permit of an electrical output of some 13,500 kW hours, the sale of which at a net profit of 1d. per unit for only 300 days in the year will produce a profit equal to 8 per cent. per annum on a total capital cost of £5,000,000 and should suffice to prevent any serious damage from flooding under all normal winter conditions so far as one may roughly judge from the recent inundation.

The scheme takes into account the intention of the Metropolitan Water Board to construct also large reservoirs in the Walton area whose capacity cannot but also prove helpful, though storage rather than flood prevention is their object.

It is beyond doubt that the country cannot afford much longer to suffer these periodic visitations in what has become practically a part of Greater London, and if we can spend the many millions contemplated on the roads, which has the disadvantage that it adversely affects the vested interests of the railways, surely we need not baulk at the capital expenditure needed to keep our main river in control when an economic scheme attractive to the ratepayer can be evolved; for it may be emphasised that in the case of flood prevention schemes all interests stand to gain by the improvement in property values and the increasing transport arising from a bigger population attracted to the district, not to name the continuous habitation all the year round of dwellings that are now but seasonal pleasure resorts perforce.

London, January 20th. S. P. CHRISTIE.

THE LOCOMOTIVE "BEDLINGTON."

SIR,—I shall be much obliged if anyone can say what railway had an engine built by Longridge and Co., 0–4–2, named "Bedlington"; their number 106, date 1838.

Wonersh, Guildford, January 17th. C. F. DENDY MARSHALL.

SIR,—*Apropos* the letter in your last issue *re* the awful word "Turbomotive," I have never been able to make out whether it is applied to the locomotive on the L.M.S. in merely a descriptive sense, or whether it is actually her name. If the latter, may I suggest that it be changed to "Turbinia," for the sake both of euphony and of historical association?

Wonersh, Guildford, January 17th. C. F. DENDY MARSHALL.

BOOKS RECEIVED.

Minerals Year Book, 1935. Washington, D.C.: The Superintendent of Documents. Price 2 dollars net.

Calvert's Mechanics' Year Book, 1936. Manchester: Wm. Endsor and Co., 5, Bridge-street. Price 6d. net.

"*Mechanical World*" *Year Book*, 1936. London: Emmott and Co., Ltd., 26, Bedford-street, W.C.2. Price 1s. 6d. net.

Petrol and Oil Engines. Fourth edition. London: The Temple Press, Ltd., 5–17, Rosebery-avenue, E.C.1. Price 2s. 6d. net.

The British Railways. By Alex. Newlands. London: Longmans, Green and Co., 39, Paternoster-row, E.C.4. Price 7s. 6d. net.

"*Mechanical World*" *Electrical Year Book*, 1936. London: Emmott and Co., Ltd., 26, Bedford-street, W.C.2. Price 1s. 6d. net.

The Young Engineer. By J. N. Digues La Touche, M. Inst. C.E. London: Technical Press, Ltd., 5, Ave Maria-lane, E.C.4. Price 5s. net.

Intermediate Engineering Drawing. By A. C. Parkinson. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 7s. 6d. net.

Aero Engines ("*D*" *Licence*). By A. N. Bassett, A.M.I.A.E. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, W.C.2. Price 3s. 6d. net.

Builders' Estimates and Pricing Data. By H. A. Mackmin, F.S.I. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 12s. 6d. net.

Electrical Measurements and Measuring Instruments. Second edition. By E. W. Golding, M.Sc. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, W.C.2. Price 20s. net.

Analytical and Applied Mechanics. By G. R. Clements, Ph.D., and L. T. Wilson, Ph.D. London: McGraw Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 21s. net.

105,000-kW. Turbo-Generator Set for Battersea.

No. II.

(*Concluded from page 100, January 24th.*)

FOLLOWING the practice adopted in the two original sets at Battersea, the governor, as shown on page 130, is horizontal, but on account of the power to be transmitted and for reasons of expansion and overall simplicity, the drive and that of the main oil pump is through helical gears instead of worm gears. With its axis parallel to the main shaft the governor is arranged on one side of the pedestal and the oil pump on the other side. Like other governors fitted to large Metrovick sets, it has ball bearings at all pivoted joints, but the relay and steam chest design differs radically from that of the other two sets in the station. On large units with duplicate groups of main steam valves on opposite sides of the H.P. cylinder the usual method of controlling the steam valve power pistons directly from the governor relay valve involves the use of a considerable length of oil piping, which tends to impair the sensitivity of governing. But by the use of mechanical links between the governor and two steam chests on this 105,000-kW machine this tendency is eliminated. Briefly, the system comprises a governor with its operating arm actuating relay valves A controlling two power pistons B, which actuate mechanical linkages C to relay valves D on each steam chest, controlling two horizontal power cylinders E with extended shafts with cams F for each steam valve. Relay valves G actuated by the cams control oil admission to the power cylinders H operating the steam admission valves, compensation being provided at each relay valve.

One advantage of this system is that the relay valves which actuate the steam valve power cylinders are formed in the power cylinders themselves, and interconnecting piping between valves and cylinders is eliminated. Rapid response to relay movement is therefore ensured. Another advantage is that the cam shaft relay valves are arranged immediately adjacent to the horizontal power pistons which they operate. The lift applied to the steam valve is, moreover, powerful and direct and free from any bending moment that might cause the spindle to bind in the guides. The steam valve power pistons, it is to be noted, are coupled to the steam valve spindles through a rigid bridge arrangement which obviates the use of oil glands under pressure.

On this 105,000-kW unit two groups of valves, each comprising an emergency stop valve and three steam admission valves, are arranged on each side of the H.P. cylinder and work in parallel, corresponding valves operating together in pairs. Each group is controlled by its own governor relay pilot valve, the two systems being entirely separate from the common governor operating arm. The first corresponding pair of valves admits steam from the steam chest to the first stage and operates for loads up to 63,000 kW; the second pair admits steam after the first stage for loads up to 84,000 kW; while the third pair admits after the ninth stage, *i.e.*, after the eighth single impulse stage, for loads up to 105,000 kW. Spring loading is provided above the power pistons operating the steam valves, and a special release chamber on each power cylinder receives released oil forced out by the spring loading when the sudden reduction in load necessitates rapid valve closing. The closing action is quicker than that obtained when oil pressure is used instead of springs, as the capacity of the oil pump must impose a time lag and there is also a retardation resulting from pipe friction.

Steam is supplied to the steam chests through four special 10in. Hopkinson centre pressure valves having a by-pass valve in the centre of the main valve and an atmospheric drain which opens after the valve is closed and so prevents steam leakage in the turbine casing, causing corrosion. Valve operation is by a single motor geared so that the atmospheric drain is closed first. The by-pass then opens and finally the working valve. When overspeed occurs the duplicated ring type emergency governor trips a valve and releases the oil pressure in the operating power cylinders of the emergency stop valve and of the steam admission valves, causing them to close by spring action. In the drawing a number of diaphragms have been omitted for simplicity. No. 3 steam valve admits steam before diaphragm No. 10 or after the eighth single stage and not after the fourth diaphragm, as shown.

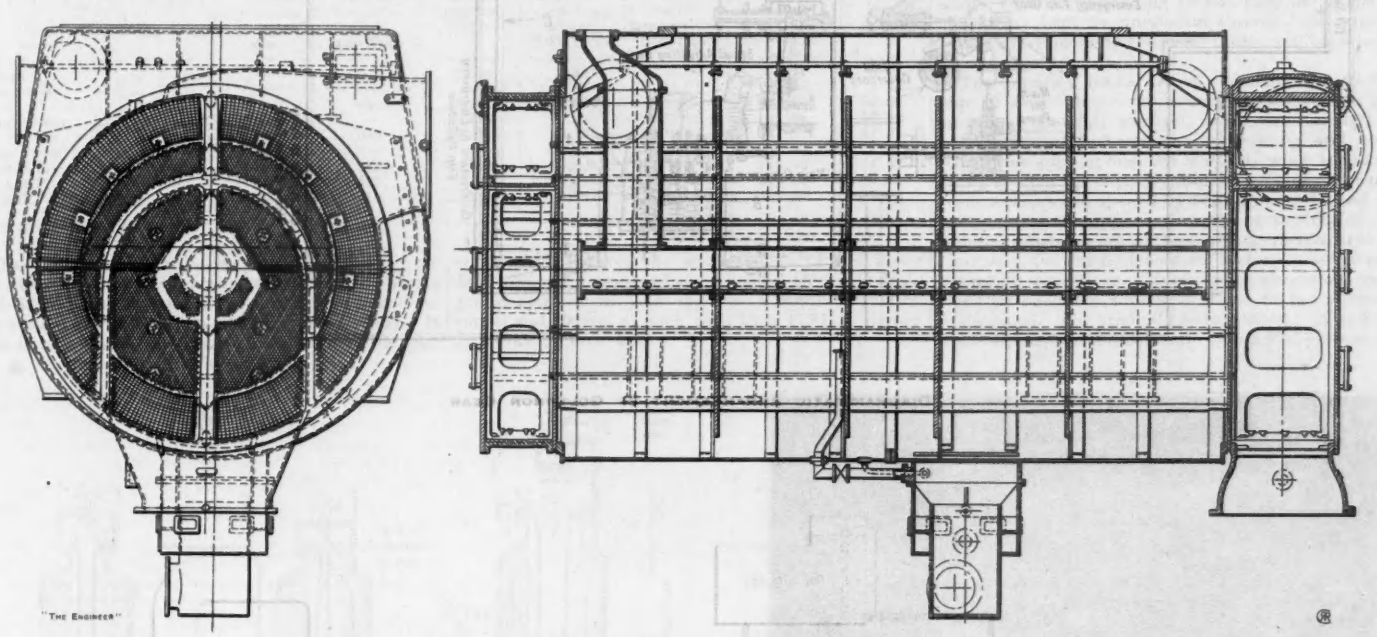
Both during the running and standing periods lubricating oil is supplied to the journals. During normal operation the amount circulated to the various bearings and to the governor relay system is about 500 gallons per minute, and after each passage through the system all the oil is given ten minutes' rest in the tank. Oil enters the suction of both the main and auxiliary pumps through a common strainer box with ten strainers with automatic shut-off valves for easy removal and replacement while the set is on load. The main positive displacement gear type oil pump raises all the oil up to governor relay working pressure, and when required gives the governor gear exceptionally quick response. By means of reducing valves the bulk of oil is then lowered to the pressure normally required in the lubricating system. As a precautionary measure "Autoklean" strainers are inserted in the oil supply to each of the thrust bearings, and the return pipework is designed to allow all oil vapour to be released from the pedestals to the main oil tank.

Two bi-rotor type pumps serve as standby pumps and for cooling the bearings during starting and stopping. Driven by 40 h.p. motors, each of these pumps is capable of delivering 300 gallons per minute against the governor relay pressure, but a by-pass across the reducing valve serves to prevent the pumps working against the full relay pressure under starting and standby conditions. If the lubricating oil pressure should drop too low, first one and then the other standby pump (fed electrically from different sources) starts automatically.

For lubricating the bearings when the rotors are being revolved slowly by the barring gear, oil at about 1000 lb. per square inch is supplied to the six main bearings from a six-throw plunger pump. Each plunger feeds one of the bearings at the rate of 1 gallon per minute, the purpose of this supply being to allow the journals to float on an oil film and thus make the rotors easy to turn at slow speeds while, at the same time, protecting the bearings from damage. Continuous oil washing and purification can be carried out if required by a Hopkinson centrifugal oil purifier in the circuit, and provision is made for warming both the oil and water during this process. All oil in the system may be drained back to a central tank and a hand pump at the lowest point in the system enables this oil to be removed without recourse to baling vessels. Similarly, the system may be filled from a central point.

All oil pipes have been kept as far away as possible from steam pipes, and where oil might possibly come into contact with the steam pipes the latter are lagged and finished off with sheet steel. As an additional precaution the set is surrounded by a Mather and Platt Mulsifyre high-pressure jet fire-extinguishing equipment arranged for hand operation and said to be capable of extinguishing any oil fire within the range of possibility of a central station. As owing to the erroneous operation of a valve switch the auxiliary oil pumps might be put out of service accidentally, a lamp is arranged to indicate to the attendant by lighting, when all valves and switches are in the correct position and the supply of oil is available. Two oil coolers, each capable of dealing with the full quantity of oil, are arranged so that either can be taken out of service for cleaning.

A cross section of one of the two central flow condensers is given below. The division of tube plates for double water flow is substantially annular in formation. The first flow is through the inner core of tubes and the return flow through the outer ring. Since the air-withdraw main is at the centre maximum cooling of the gas withdrawn is assured. Both shells of the two condensers are composed of welded steel plate with reinforcing channel sections. They are bolted directly to the turbine exhaust flange, and springs below the feet of the shells carry part of the condenser weight and allow for expansion. Each condenser has a cooling surface of 45,000 square feet. There are 7000 1in. diameter tubes, composed of Admiralty mixture, in each shell, and they are 24ft. 6in. long.



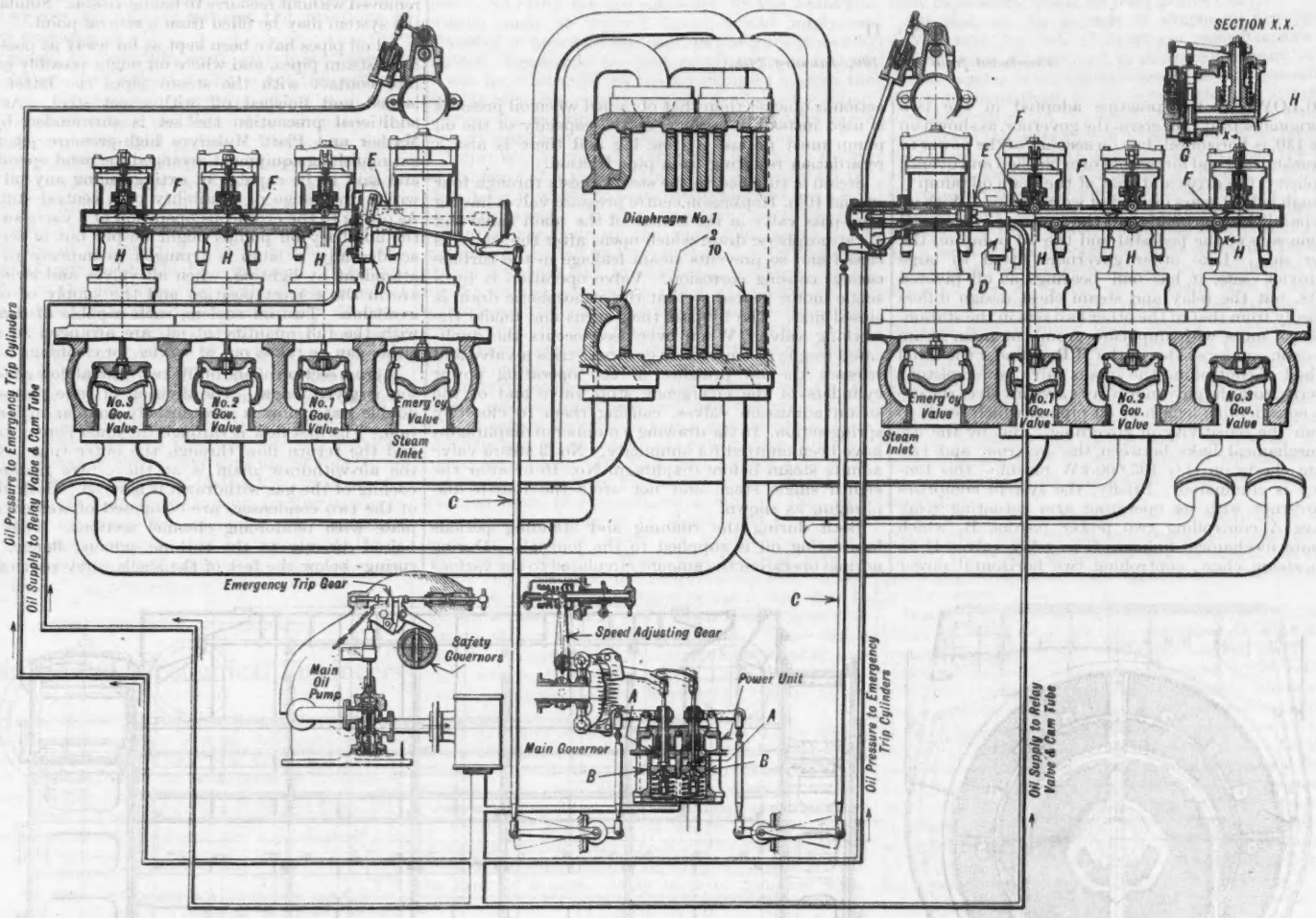
SECTIONS THROUGH MAIN CONDENSER

Circulating water is taken from the river through screens to a common pumping station in which the pumps are arranged to discharge into a common main from which each of the three main sets in the station takes its supply of circulating water. With its isolating valves and connections the common main is arranged so that each condensing plant is normally supplied by two electrically driven pumps operating in parallel. To enable an increased quantity of water to be circulated if necessary, the pipe connections to each set are of very large diameter. The height of the condenser water-box above the lowest tide level in the river was arranged to limit the maximum syphon effect in the return pipe to 29ft.

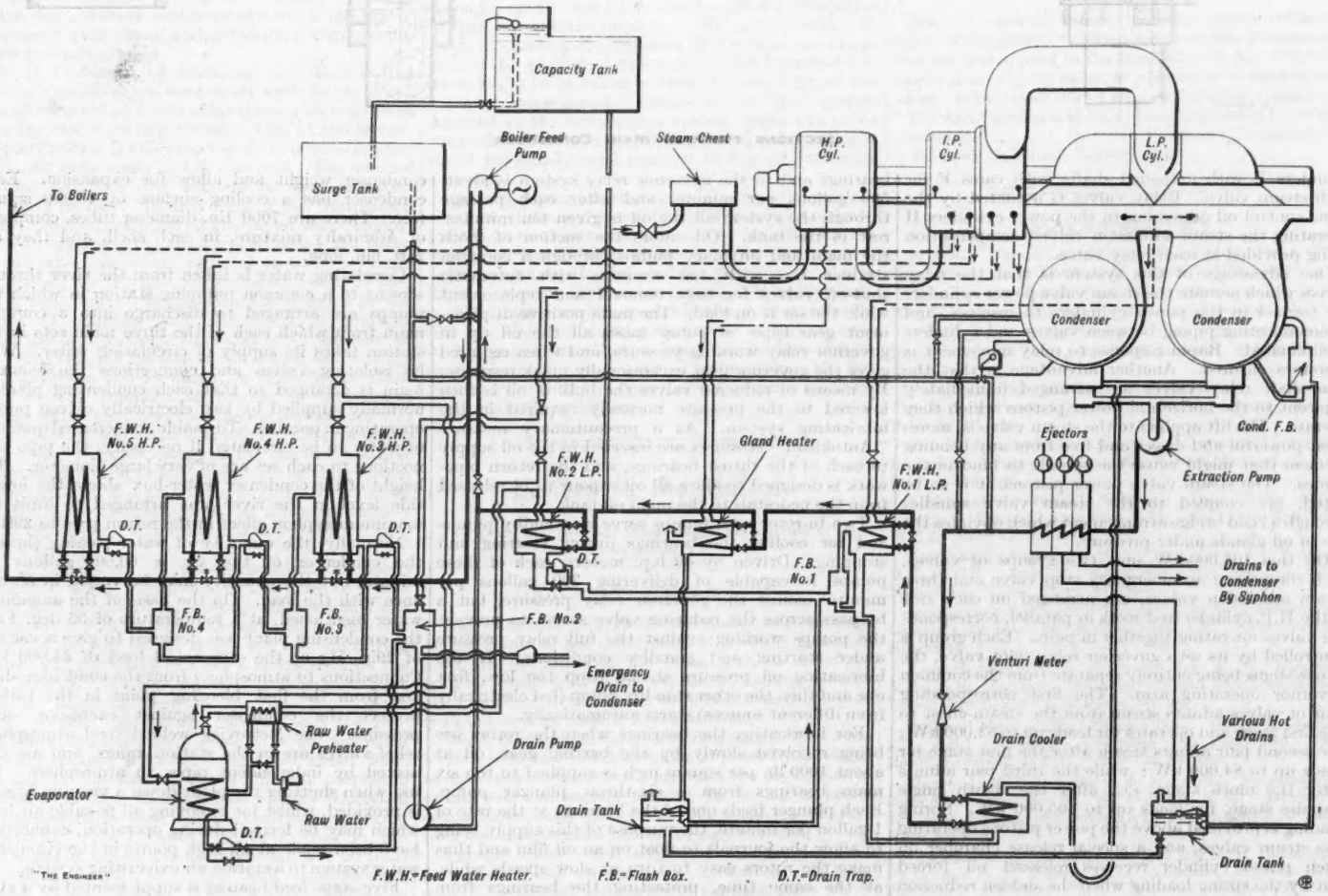
Normally, the quantity of water passing through the condenser of the set is 60,000 gallons per minute, but the quantity may be varied in accordance with the load. On the basis of the amount of water mentioned, at a temperature of 55 deg. Fah., the condensing plant was designed to give a vacuum of 29in. Hg at the economical load of 84,000 kW. Connections to atmosphere from the condenser shells and from the first bleeding point in the turbine protect the condenser against excessive steam pressure. The Metrovick welded steel atmospheric relief valves are in the station annex, and are connected by independent pipes to atmosphere. For use when shutting the plant down a vacuum breaker is provided, whilst for removing all possible air locks which may be formed during operation, connections have been made at all high points in the circulating water system to a station air exhausting system.

Five-stage feed heating is supplemented by a gland heater, a drain cooler, and the surface type of coolers

BATTERSEA 105,000-kW GENERATOR—GOVERNOR GEAR AND FEED SYSTEM

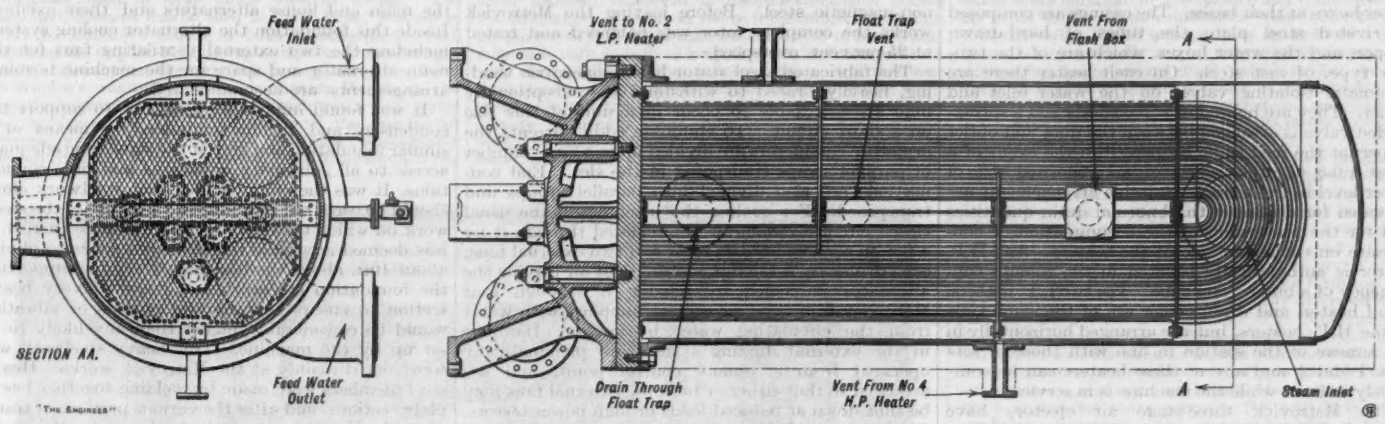


DIAGRAMMATIC ARRANGEMENT OF GOVERNOR GEAR



FEED HEATING DIAGRAM

of the air ejectors. There are three evaporators operating in single-stage effect. Two meet the normal make-up of 3 per cent., while the third provides 50 per cent. standby capacity. A simplified diagram of the feed circuit is given on page 130, and below a table showing the steam and water conditions at each point in the system with the evaporator in service at the economical load of 84,000 kW.

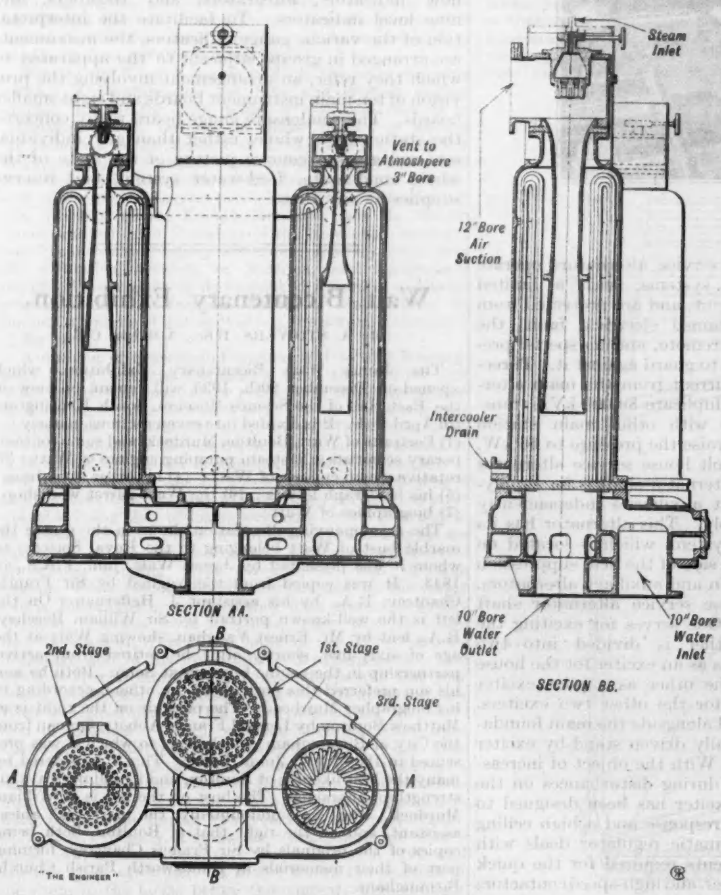


SECTION OF H.P. FEED HEATER

TABLE I.—*Feed Heating at 84,000 kW with Evaporator in Use, 3 Per Cent. Make-up.*

Feed heating stage.	Steam pressure, lb./sq. in. abs.	Steam temperature, deg. Fah.	Steam quantity, lb./hr.	Heat content of steam, B.Th.U./lb.	Feed inlet temperature, deg. Fah.	Feed outlet temperature, deg. Fah.	Feed rise, deg. Fah.
Ejector	—	—	2,600	1,411	78·00	83·14	5·14
Drain cooler	—	—	—	—	83·14	90·84	7·70
No. 1 L.P.	5·2	Wet	41,974	1,077	80·84	153·86	63·02
Gland heater	Atmos.	—	7,590	1,300	153·86	166·66	12·80
No. 2 L.P.	16·5	Wet	21,327	1,136	166·66	207·90	41·24
Drain pump	—	—	—	—	207·90	209·52	1·62
No. 3 H.P.	45	325	43,518	1,200	209·52	264·35	54·83
No. 4 H.P.	83	423	33,345	1,244	264·35	304·45	40·10
No. 5 H.P.	137	510	31,315	1,284	304·45	340·00	35·55

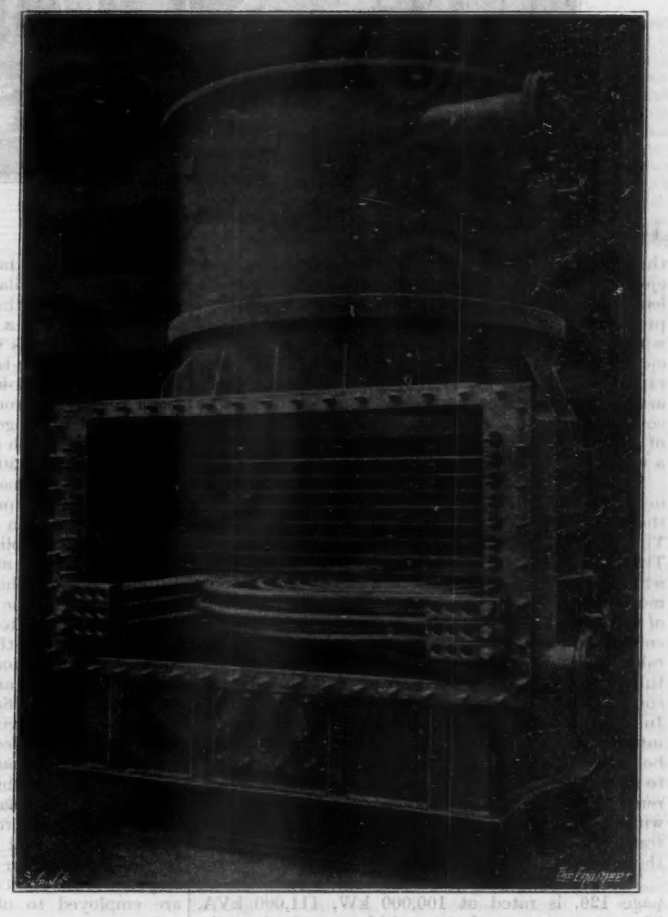
Operating steam for the evaporators is taken from the turbine tapping supplying the first H.P. heater and the make-up vapour is led to the steam space of the second L.P. heater, in which it is condensed. It then finally passes together with the normal drainage of the L.P. heaters to a de-aerating hotwell at the base of the condenser. The drains enter the de-aerating hotwell at a point where the pressure is maintained slightly in excess of the condenser pressure by means of a small static head, which may be varied at will, thus making it possible to avoid flushing the drains to the main condenser vacuum temperature. The temperature of combined condensate leaving the hotwell can thus be brought to as much as 8 deg. to 9 deg. Fah. in excess of the vacuum temperature, which represents an appreciable gain in economy. There are flash boxes on the drains from each of the H.P. heaters and the vapour from them discharges into the steam space of the next heater. The drains are returned to the feed line on the suction side of the boiler feed pumps by means of a duplicated Drysdale drain pump coupled in each case to a main extraction pump and driven in each case by a 175 h.p. motor, as shown on page 126.



SECTION OF THREE-STAGE EJECTOR

Irregularities in the boiler feed pump demand relatively to the extraction pump output throughout the station are met by three large surge tanks and two capacity tanks. From each main set a connection is taken from a point at the inlets to No. 2 L.P. heaters to a capacity tank bus main connected in turn to two capacity tanks, 82ft. above the basement level. When the boiler feed pump demand is low these tanks take any surplus water and supply any water deficiency when the demand is high, relatively to the extraction pump output. A float controlled overflow connection on each of these tanks is connected through a bus main to the surge tanks. To avoid water standing in the capacity tanks becoming aerated a circulation is maintained in these tanks by a small hand-controlled re-circulating system between the surge main and the main condensers on each set. Thus a small additional quantity of water over and above that corresponding to the machine output is constantly kept in circulation through the capacity tanks, overflowing to the surge tanks, and back to the main condensers.

The capacity tanks are of sufficient size to take care of all normal surge demands. To meet a long sustained demand, however, cross connections have been provided between the surge main and boiler feed pump suction bus, but it is only when the excess static head of the capacity tanks disappears that non-return valves are opened by the surge tank head and surge water is supplied directly to the boiler feed pumps, which, owing to these arrangements, are continuously fed with deaerated water under normal operating conditions. Even under abnormal conditions an adequate supply of water to the pumps is maintained. The original systems fitted to Nos. 2 and 3 sets worked on the Contraflo closed feed system, and to enable satisfactory parallel operation to be obtained between the three sets it was necessary slightly to modify the closed feed valves to those sets. The motor-operated Mather and Platt feed pump is capable of developing a pressure of 785 lb. per square inch when delivering 1,100,000 lb. of water per hour



EVAPORATOR UNIT

and is driven by a 1500 b.h.p., 3000 r.p.m. Metrovick squirrel-cage motor.

The three Metrovick inverted "hairpin" type high-pressure feed heaters are mounted vertically alongside the turbine on brackets formed on the water boxes at their bases. The casings are composed of riveted steel plate, the tubes of hard-drawn copper, and the water boxes, which are of the two-flow type, of cast steel. On each heater there are automatic isolating valves on the water inlet and outlet. They are housed in valve chests and a spring-loaded valve is arranged between the inlet and outlet to permit the feed to be by-passed in the event of a burst tube or other cause of an abnormal rise of water level in the heater. Suitable arrangements are provided for dealing with abnormal drain quantities and for the prevention of the accumulation of condensate on the steam side of the heaters. Any H.P. heater is automatically isolated in the remote contingency of a burst water tube. The two L.P. heaters, gland heater, and drain cooler are of the same type as the H.P. heaters, but are arranged horizontally in the annexe of the station in line with those of sets Nos. 1 and 2, and any of these heaters can be completely isolated while the machine is in service.

The Metrovick three-stage air ejectors have "inter" and after coolers, and it will be perceived from the sector that a triangular disposition of the three stages has been adopted. The casings and water boxes are of cast iron and the tubes of hard-drawn brass. The water box for each stage has a concentric dividing partition enabling both ends of the U-shaped tubes to be expanded into the tube plate and allowing the tubes perfect freedom for expansion. Each ejector can deal with the anticipated normal air leakage and 100 per cent. standby capacity is thus provided. Actually the quantity of air to be dealt with is abnormally small, and either one of the ejectors works with a considerable margin. For rapidly exhausting the system prior to starting there are two single-stage exhausters, and when used in conjunction with the second and third stages of one of the main ejectors the system can be exhausted to a vacuum of 20in. Hg in about eight minutes.

Two of the three single-stage effect evaporators, deal with the normal 3 per cent. make-up and the third acts as a 50 per cent. capacity standby. They are Metrovick horizontal coil type evaporators. The lower portion contains the steam tube coils, while the upper part, formed as a large dome, accommodates moisture separating baffles. On each side of the welded plate shell there are cleaning doors to enable the base to be scraped clean with the aid of a rake. Compounded of heavy gauge copper, the tubes are formed in a series of independent flat coils, each consisting of three tubes in parallel. Inlet and outlet ends of each coil are expanded into separate coil end boxes, one of which is bolted to the main inlet steam header and the other to the drain header, a construction which permits the removal of one coil from the evaporator for cleaning without disturbing the remaining coils. A rack framework supports the coils and serves as a guide for the removal of tubes.

The main alternator, of which views are given on page 126, is rated at 100,000 kW, 111,000 kVA, 90 per cent. power factor, which, as stated at the outset, constitutes a record for alternators built in Europe. At full load the temperature rise is guaranteed not to exceed the values allowed in the special B.S.I. rules for turbo-alternators, viz., 80 deg. Cent. for the stator, measured by an embedded thermometer, and 90 deg. Cent. for the rotor, measured by the resistance method. Built up of three separate forgings, the rotor is 58in. in diameter, and weighs 82 tons. The forgings are assembled and kept in position by shrunk rings of high tensile alloy steel. To reduce losses due to stator and rotor leakage fields, the coil retaining rings are of a specially high-tensile non-magnetic steel. Before leaving the Metrovick works the complete rotor was balanced and tested at 25 per cent. overspeed.

The fabricated steel stator has a concentric winding, heavily braced to withstand the exceptionally high stresses liable to occur in a unit of this size on a short circuit. To eliminate eddy currents the armature conductors are divided up in a large number of parallel straps transposed in the slot. End connections are also divided into parallel groups and transposed. For cooling the machine on the usual closed circuit system, air is circulated through it by a fan on each end of the rotor and two external fans, each driven by a 135 h.p. motor. Hot air leaving the alternator is cooled by passing it through four Metrovick-Still type air coolers, supplied with water from the circulating water bus main. Dampers in the external ducting system are pneumatically operated from a remote control point, and are arranged so that either or both the external fans may be shut down at reduced loads or high power factors. In the event of the air coolers being out of action, cold air may be drawn from the basement at one point and heated air discharged into the turbine room at another point. Access doors enable the whole of the external ventilating system to be inspected at any time. Excessive temperature of air in the ventilating system is indicated by the usual alarm device.

STEEL FOUNDATION FOR TURBINE

As the main and house service alternators operate with closed ventilating systems, with a limited quantity of air in the circuit, and are protected from all possibility of a sustained electrical fault, the possibility of fire is very remote, and no special precautions have been taken to guard against it. Three-phase, 50-cycle, 11-kV current from the main alternator is passed through duplicate 80,000-kVA transformers, interchangeable with other main station transformers, which also raise the pressure to 66 kW.

The 6250-kVA, 3000-volt house service alternator on the end of the main alternator shaft is for supplying power to the present auxiliaries independently of the main station supply. This alternator has its own closed air cooling system, which is located on the +14 floor level at the side of the field suppression switches for both the main and auxiliary alternators. On the end of the house service alternator shaft there are two exciters. One serves for exciting the main alternator, the other is divided into two sections. One section acts as an exciter for the house service alternator and the other as a pilot exciter for supplying the fields for the other two exciters. At the basement level and alongside the main foundations there is an electrically driven stand-by exciter for the main alternator. With the object of increasing the station stability during disturbances on the grid system, the main exciter has been designed to give an extremely rapid response and a high ceiling voltage. A special automatic regulator deals with the large excitation currents required for the quick response of the main exciter, and high-speed contactors are employed to obtain the maximum excitation voltage.

Apart from the fabricated yoke, the main alternator stator, which weighs 148 tons, was built completely on site. The transportation of the yoke from Manchester to London involved very special arrangements on the part of the railway companies, and the job had to be carried over two week-ends. The sub-base foundations for the set were carried down until the gravel bed was reached, some 10ft. to 15ft. below the turbine room basement, and a raft was made, finishing at the basement level. On this raft was built a concrete foundation suitably reinforced and furnished with steel insets for carrying the main and house alternators and their exciters. Inside this foundation the alternator cooling system, including the two external ventilating fans for the main alternator and spare for the machine terminal arrangements, are accommodated.

It was found impossible, however, to support the condensers and turbine cylinders by means of a similar foundation and give at the same time adequate access to all subsidiary apparatus and pipe connections. It was therefore decided that steelwork alone should be used, but to minimise the depth of the steelwork on which these live loads were to be carried, it was deemed advisable to build up a concrete plinth, about 10ft. above the basement level, for supporting the foundation steelwork, composed of very heavy section to ensure that natural periods of vibration would be considerably higher than any likely to be set up by the machine. This heavy steelwork was constructed mainly at the Metrovick works. Heavy steel members were made by welding together heavy plate sections, and after the various portions of transportable dimensions were located on site, they were formed into one continuous structure by welding, as shown below. As the space left in the station was originally intended to accommodate a 67,200-kW set, the lay-out of auxiliary apparatus had to be very carefully considered, but it will suffice to say that the longitudinal centre line of the new set has been kept in line with that of the two existing sets. All hand rails have also been kept in line, and the complete plant presents a very symmetrical appearance. All H.P. steam piping, supplied by Aiton and Co., of Derby, is fitted with Corwell joints.

To enable the engineers to ascertain the exact heat consumption of the set per electrical unit generated, permanent provision has been made for current transformers in the neutral side of the alternator windings, and space is available for the installation of potential transformers. All these transformers are in addition to those required for normal station operation, and are easily removed. On the steam side, arrangements have been made for removing all condensate from the system between the gland heater and No. 2 heater by means of a special pump and for passing it through a system of weighing tanks and returning it to the system again at the same point. Thus, after due corrections have been made, an exact measure of the steam supplied to the machine can be obtained. There are eighty-two pressure and vacuum gauges, thirty-seven temperature indicators and recorders, twenty-six flow indicators, integrators, and recorders, and nine level indicators. To facilitate the interpretation of the various gauge indicators, the instruments are arranged in groups adjacent to the apparatus to which they refer, an arrangement involving the provision of ten main instrument boards and eight smaller boards. The condensate gauge board really concerns the station as a whole, rather than any individual set, and gives a concise picture of the state of the whole condensate, feed-water system, and reserve supplies at any time.

Watt Bicentenary Exhibition.

By A. STOWERS, B.Sc., A.M.Inst.C.E.

THE James Watt Bicentenary Exhibition, which opened on December 20th, 1935, will remain on view in the East Hall of the Science Museum, South Kensington, till April 19th. It is divided into seven sections, namely:—(1) Portraits of Watt, Boulton, Murdock, and some contemporary scientists; (2) steam pumping engines of Watt; (3) rotative steam engines of Watt; (4) his other inventions; (5) his holograph letters; (6) the Watt garret workshop; (7) biographies of Watt.

The accompanying illustration shows in the centre the marble bust of Watt belonging to the Royal Society, to whom it was presented by James Watt, jun., F.R.S., in 1843. It was copied from the original by Sir Francis Chantrey, R.A., by his assistant J. Heffernan. On the left is the well-known portrait by Sir William Beechey, R.A., lent by Mr. Ernest Vaughan, showing Watt at the age of sixty-five, shortly after he retired from active partnership in the engine business at Soho. Both he and his son preferred this portrait to the others, according to his biographer Muirhead. The portrait on the right is of Matthew Boulton by Lemuel Francis Abbott, on loan from the City of Birmingham Art Gallery, to which it was presented in 1908 by Sir John Holder. This is considered by many the best likeness of Boulton, and it well portrays his strength of character. The bust on the left is of William Murdock, who was undoubtedly the partners' ablest assistant, and on the right that of Boulton, both being copies of the originals by Sir Francis Chantrey, forming part of their memorials in Handsworth Parish Church, Birmingham.

The Exhibition comprises over 300 items of interest, described in detail in the special catalogue (price 9d.), containing a reproduction of the celebrated portrait of James Watt in his seventy-seventh year by Sir Thomas Lawrence, R.A., and on the cover a silhouette of the Sun and Planet Engine, now preserved in the Science Museum, known as the "Lap" engine, which was erected for Boulton in 1788 in Soho manufactory. It is only possible here to mention a few objects of outstanding interest. Two exhibits, though small in size and of crude con-

struction, are of unequalled importance in the development of the steam engine, namely, the two original separate condensers of 1765, on which Watt experimented when making his most important invention. The second, with its 140 small water tubes, is the prototype of the surface condenser used in large power stations to-day. The honoured remains can be seen of "Old Bess," erected in 1777 to Boulton's orders in Soho manufactory, which replaced the original Kinneil engine that had been brought there. Nearby is the original boring bar from John Wilkinson's ironworks, at Bersham, near Wrexham, the greatly improved performance of which was a vital factor in the success of Watt's engines. Of the number of original models from the Watt Collection, permanently preserved in the Science Museum, may be mentioned the

PORTRAITS AND BUSTS OF WATT, MURDOCK AND BOULTON

pumping engines made for the lawsuit *v.* Bull, the crank substitutes devised to circumvent Picard's patent, tilt hammers, and flour mills obviously made to obtain data for the designs of full-sized machines.

Besides the "Lap" engine of 1788, the most imposing exhibit is undoubtedly the Sun and Planet engine, erected in 1797 for John Maud, a wholesale chemist of Aldersgate-street, London, in whose factory it worked till removed to the Museum in 1885. The sound of this engine running, together with tributes to James Watt from Colonel A. E. Davidson (the President of the Institution of Mechanical Engineers), Colonel E. E. B. Mackintosh (the Director of the Science Museum), and Mr. H. W. Dickinson (a former President of the Newcomen Society), was broadcast on Sunday afternoon, January 19th, over the Columbia network in America, and particularly delighted a company of distinguished American engineers assembled in the Franklin Institute, Philadelphia, to honour the name of James Watt on the actual bicentenary of his birth.

A number of drawings of engines lent by the Birmingham Public Libraries Committee from the Boulton and Watt Collection there, show graphically the development of the steam engine due to Watt. The early drawings are undoubtedly by Watt himself up to 1782, when John Southern joined the firm as his draughtsman and assistant.

Evidence of Watt's methodical testing of engines is well shown by the various notebooks of performances of atmospheric, Cornish, and other engines, perhaps the most valuable being that of his experiments on his first engine at Kinneil. Of his other inventions, actual examples are exhibited of his engine counter, indicator, perspective apparatus, copying press, micrometer, and dividing engine. From the one hundred letters lent by the Assay Office, Birmingham, to which they were presented by the Boulton Trustees, vivid accounts, many with sketches, may be read in Watt's own hand of his difficulties, his ill-health, and of his inventions and experiments. Two items of special interest which were discovered last year by Mr. Westwood, the Assay Master of Birmingham, are Watt's original draft of his "Instructions for the Erection of Engines" (1778), and his covering letter from Cornwall to Boulton relating the effort which it cost him. Other items are a detailed chronology of Watt's life and a map of Great Britain showing the geographical distribution of the 496 engines for which the famous Soho firm were responsible during the years of the partnership, 1775–1800. Finally, the garret workshop from Watt's house built at Heathfield, near Birmingham, in 1790, still attracts great attention. A model shows the position of the room in the house before the contents were brought to South Kensington in 1924. Personal belongings, tools, and books have been selected for exhibition, besides many examples of the small busts and other objects of art which Watt made, during his last years, on the two sculpture machines which are preserved in the workshop.

THE value of aeroplanes and aero-engines exported from this country during 1935 amounted to £2,680,729.

The Cantieny High-Pressure Boiler.

EXPERIMENTAL work has shown that with tubes of the usual diameter employed in natural circulation boilers the circulation of water in rising tubes subjected to high temperatures is so rapid that the coefficient of heat transmission is high enough to keep the tube wall temperature very close to that of the saturated steam, and this confirms the use of fully cooled combustion chambers for high-pressure installations. It has also been clearly shown that damage to heated tubes only occurs in tubes where, owing to some defect in circulating arrangements, the water is allowed to descend. The relative velocity of steam bubbles to that of water is low at high pressures, so that in a tube in which water is descending at the same time as steam is being forced conditions may arise in which the steam bubbles will remain stationary with the inevitable result that overheating of the metal will occur.

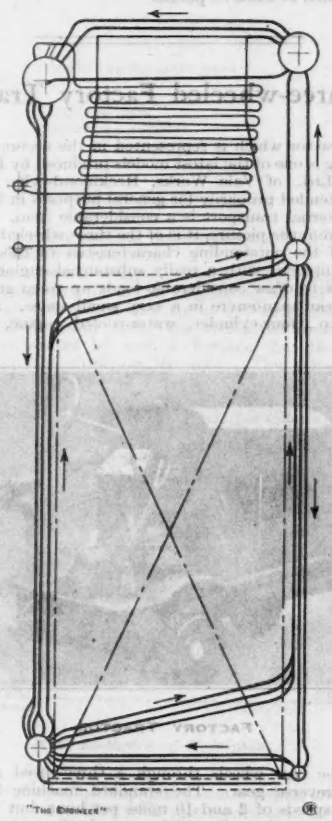


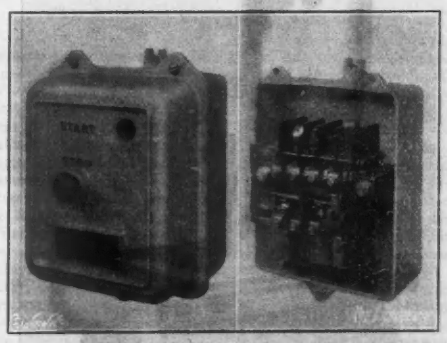
DIAGRAM OF CANTIENY BOILER

followed by failure of the elements involved. The consideration of these and other factors equally important in arriving at the final result has produced what is believed to be a very real advance in the design of natural circulation steam generation, which has been called the Cantieny boiler, manufactured and sold in this country by International Combustion, Ltd. In its primary form the Cantieny boiler is a steam generator of the type which has a furnace cooled with tubes which generally are connected to diagonally opposed drums or headers. In previous designs the circulation has been maintained by downcomer tubes external to the furnace and connected from the drum ends. Certain difficulties were found to exist, however, owing to the setting up of an axial flow in the drums, which not only set up considerable resistance to motion, but had a serious disadvantage in that its effect was most marked at the drum ends; at the same time, the laterally placed walls discharge their steam water mixture to the same drum ends, so that a definite restriction of flow is produced.

To overcome these disadvantages the new design provides for a recirculation over the entire length of the upper drum, these recirculation tubes being naturally located outside the heating zone and an additional steam and water drum is provided with its steam space connected to the upper furnace drum by rows of tubes and its water space connected to the lower drum by tubes evenly spaced over the whole drum length. These tubes form the main feed supply to what may be conveniently described as the parallelogram system of the boiler. The discharge tubes of the collecting headers of the side wall tube systems are also spaced over the drums. In this way the whole of the flow circuits can be co-ordinated and by a suitable relation between tube resistance and static head separation of steam and water takes place in the top drum of the parallelogram system; the separated water is recirculated from this drum round the system. This steam passes to the main steam and water drum suitably arranged at a higher level, from which the steam is drawn off to the superheater. The normal feed supply is also introduced into this drum in any conventional manner. The condition of throttled circulation which results in a separation of water steam mixture in the recirculating drum and gives a discharge of substantially water-free steam makes this system particularly useful for the adaptation of water cooling to the furnaces of existing boilers, in that the capacity is greatly increased while the steam generation of the boiler proper is not disturbed, and it was in this connection that the system was first developed. Since then a number of boilers have been designed and constructed in Germany on these lines over a wide range of both pressure and output. They are designed for both pulverised fuel and stoker firing, and the accompanying drawing shows a pulverised fuel unit. We are informed that boilers are in satisfactory operation for pressures up to 600 lb. per square inch and outputs up to 22,000 lb. per hour, and several installations are now under construction for pressures up to 1950 lb. per square inch and outputs up to 350,000 lb. per hour. Tests, it is claimed, have shown that with the medium-pressure boiler it is possible to carry high concentrations of solids without any difficulties due to priming or carry over in the steam, and equally satisfactory results are expected from the high-pressure units.

A.C. Push-Button Starters.

A NEW push-button "straight-on" starter for squirrel-cage motors has been brought to our notice by M. and C. Switchgear, Ltd., of Kelvinside Works, Kirkintilloch, Glasgow. Two models are made, one having two self-resetting trips, and the other three hand-resetting trips, which may be operated by float switches and similar devices. Both models conform to B.S.S. No. 587, and are capable of starting motors of the following horse-powers and voltages, provided the standstill current does not exceed 50 ampères:—Three-phase: 3 h.p., 220/250 volts, and 5 h.p., 400/440 volts. Two-phase: 7½ h.p., 660 volts; Single-phase: 2 h.p., 220/250 volts; 3 h.p., 400/440 volts, and 5 h.p., 660 volts. The vertically



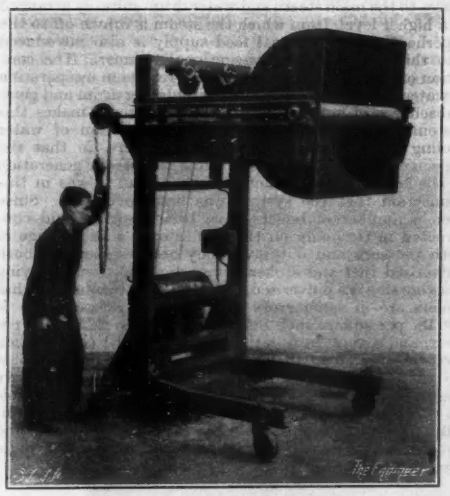
A.C. PUSH-BUTTON STARTER

operated contactor has four identical sets of contacts, three for the main current, and one for maintaining the operating coil circuit. All fixed contacts are of heavy copper section supported by double springs, while the self-aligning moving contacts are of tubular copper and give a good rubbing action. The unit is assembled on a Bakelite moulding with moulded arc shields between each set of contacts. A self-aligning armature below the contacts operates the contactor. The two over-current trips on the first-mentioned type of starter are of the thermal self-resetting type. As the bi-metal strip does not carry main current it is of the same relatively heavy section throughout the whole range of power ratings, and cannot be burnt out. The heating element has a high melting point and is claimed not to deteriorate with repeated heating and cooling. An overload adjuster with three positions adjusts both trips simultaneously, and after operation the contacts are automatically reset. It is therefore only necessary to press the start button to restart the motor, a feature of considerable value in the case of remote push-button operation, since a visit to the starter for resetting purposes is unnecessary. Under voltage protection is inherent in the contactor.

The "start," "stop" push buttons are mounted in the starter cover and actuate contacts on the contactor unit. There are no flexible connections. The red stop button is of the mushroom pattern, and is mounted above the start button, which is shrouded for protection against accidental operation. Apart from the fact that the alternative starter has three hand-reset, over-current trips, its construction corresponds with that described. The over-current trip adjuster gives simultaneous adjustment to the three trips, and has three positions, giving suitable variations in tripping values. The three elements operate a common trip bar, which breaks, in turn, the trip contacts with quick break action, and the trips give a time lag in inverse proportion to the value of the overload. As the internal parts of these starters form a complete unit, the unit can be supplied for incorporation in other apparatus. External and internal views of a starter having two self-resetting trips are given.

A Batch Transferring Machine.

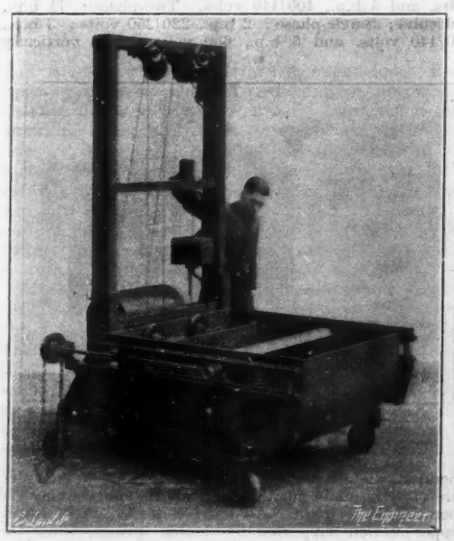
THE special machine which we illustrate in the two half-tone engravings has been made by Herbert Morris, Ltd., of Loughborough, for service in a chocolate factory. Its function is to transfer batches of liquid chocolate from one processing machine to another and to raise them to an



CHOCOLATE BATCH TRANSFERRING MACHINE

appropriate height for pouring into the hopper of the second process.

As will be seen, the chocolate is held in a stainless steel skip of semi-cylindrical form, pivoted in a framework. This frame is mounted on a truck with four castor wheels, and equipped with two uprights up which the frame can be hoisted by means of a small electric winch and wire ropes. The skip is filled in the lower position and the machine pushed to its destination by hand. The frame and skip are then hoisted to the upper position and tilting, to discharge the contents, effected by the hand chain shown. This

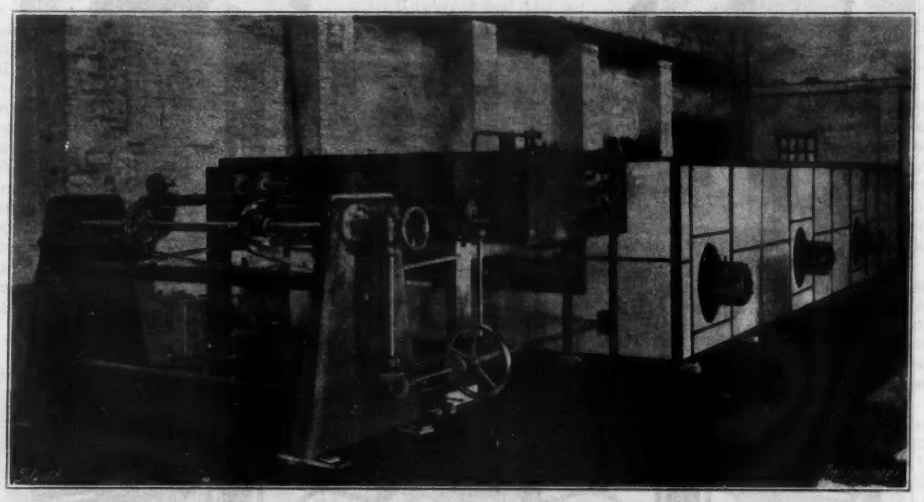


BATCH TRANSFERRING MACHINE WITH SKIP LOWERED

chain operates a screw that pushes the trunnion blocks of the skip forward in slides in the rising frame. A toothed sector engages with a rack on the frame and tilts the skip as it moves forward, so that the pouring lip does not recede as tilting progresses, and there is no spillage.

A Large Latex Drying Machine.

IN THE ENGINEER of August 16th last, page 167, the process used in the drying machinery built by the Spooner Dryer and Engineering Company, Ltd., was described, together with some of the machines made by the firm. We are now able to show in the accompanying illustration one of the Spooner Dryer and Engineering Company's largest products. It is an installation for the process drying of latex rubber used as a coating material. The machine illustrated consists of a Spooner steamer and a battery of three large dryers forming a unit and traversed by tentering chains. The material is fed from a spreader head on to these chains and passed through the machines. It is then removed and batched. The whole process is continuous and light fabrics treated with Latex are passed out dry at the rate of 40 yards per minute, while fabrics up to ten times the weight may also be dried at a speed of 4 yards per minute approximately. As was explained in the description given in the earlier article, the material to be dried is first steamed until it has reached a predetermined temperature and humidity throughout. It is then passed into the dryer, where by means of directed



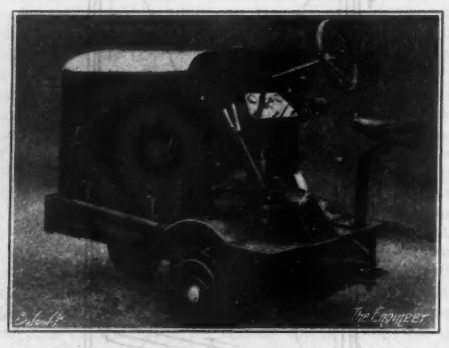
INSTALLATION FOR DRYING LATEX RUBBER

streams of air, the moisture is removed. Case hardening of the material due to the drying process taking place more rapidly on the outside is avoided by the previous steaming, which provides an adequate moisture content in the material as well as a temperature such as to compensate for the temperature loss due to evaporation during drying. The material is passed through three dryers, in each of which a stream of air operates, the temperature and moisture content of which is controllable at the inlet. The process is thus completely under control and is particularly suitable for difficult materials such as latex. Variations of temperature within the machine have been allowed for by the provision of flexible couplings to allow for expansion, and the widening gear for the chains can be adjusted easily with one hand. The provision of an electric servo motor increases the speed of this adjustment, and controls of the push-button type are provided at suitable points.

A Three-wheeled Factory Tractor.

THE tractor which is represented in the accompanying engraving is one of the latest models produced by Reliance Trucks, Ltd., of Vale Works, Heckmondwyke, Yorks., and is intended primarily for general purposes in factories where internal transport is a considerable item. As will be seen from the picture, it is of the three-wheeled type.

One of the outstanding characteristics of this tractor is its equipment with a really substantial engine, which enables it to draw considerable loads up steep gradients, while it can manœuvre in a very small space. It has a 12–24 h.p., four-cylinder, water-cooled engine, driving



FACTORY TRACTOR

on to the rear wheels through a three-speed gear-box with a reverse gear. The standard machine has two running speeds of 2 and 10 miles per hour, but the gear can be arranged to give higher speeds if required. The maximum draw-bar pull is 2000 lb. Steering is, of course, effected by the single front wheel, and the minimum circle round which the wheels will turn is 6ft. 8in. in diameter, but it requires a circle of 10ft. diameter to accommodate the overhang of the frame. The wheel base is 3ft. 4½in. long, and the tread 2ft. 10in. between the centres of the tires. The overall length is 7ft. 6in., the width 3ft. 3½in., and the weight 26 cwt.

British Standards Institution.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

CAPPING METAL FOR STEEL WIRE ROPES.

No. 643—1935. This new Specification is an addition to the extensive series dealing with terminal fittings for wire rope and chain. The Specification was prepared by a representative Committee, on which, among others, wire rope makers, white metal alloy makers, and the Safety in Mines Research Board were represented. Collaboration between the colliery and engineering interests has resulted in the adoption of a single white metal alloy suitable for all sockets, whether for colliery wire ropes or for more general use, although previously the metals employed varied widely in composition. The Specification deals with the composition and analysis of the metal and methods of sampling, and an appendix gives details of a recommended method of socketing.

ASPHALTIC BITUMEN ROAD EMULSION.

No. 434—1935. This Specification is a revision of one issued in 1931. Apart from tightening the limits imposed in several particulars, the main points of difference between the old and the revised issues are in regard to the limits of viscosity for various methods of use and in the introduction of the new Lability Test. The Lability Test enables emulsions to be classified, so that it can be determined whether they belong to the type suitable for surface dressing and grouting, or possess too great a stability to be employed successfully for these purposes.

STANDARD UNIT WEIGHTS OF BUILDING MATERIALS.

No. 648—1935. The object of this schedule is, not so much to afford more accurate data for calculations, but to standardise the data employed, in order to avoid the confusion which arises when comparing building calculations based on different data. In some cases, when plans of buildings are submitted to local authorities for review, they are very limited in the description of the materials employed. The roofing may be described merely as slates, tiles, &c., or the gutters simply as cast iron. The schedule is an attempt to secure agreement by indicating the weight to be assumed. The weights given do not represent those of any particular sample, but are arbitrary figures fixed solely as representing fair average values for the particular material. Where accurate calculations are required the weight of the actual material to be used should be determined directly.

INTERNAL COMBUSTION ENGINES FOR STATIONARY AND INDUSTRIAL PURPOSES.

No. 649—1935. The Institution has recently issued a new Specification, No. 649—1935, for Internal Combustion Engines. This Specification supersedes the following British Standard Specifications, which are now withdrawn :—

No. 120—1925. Gas Engines for Electrical Purposes.
No. 211—1925. Heavy Oil Engines for Electrical Purposes, Diesel Type, Air Injection.
No. 212—1925. Heavy Oil Engines for Electrical Purposes, Surface Ignition Type.
No. 213—1925. Heavy Oil Engines for Electrical Purposes, Airless Injection, Cold Starting Type.

These earlier Specifications were applicable only to engines for electrical purposes, whereas the present revision has been amplified to cover all internal combustion engines (excluding those of the carburetter type) for stationary and industrial purposes and for auxiliary purposes on shipboard, and was prepared jointly by the Electrical and Mechanical Sections of the Institution. The preparation of a Standard Specification for Internal Combustion Engines of the carburetter type is in hand. The revised Specification is broadly in line with the proposals for the performance of internal combustion engines now being considered internationally.

Echo-Sounding Equipment for Ships.*

By Captain J. F. HUTCHINGS.

SOUNDING is, of course, as old as ships, and for centuries has consisted in lowering a weighted line to the sea bottom and measuring the length of the line to find the depth. It takes about 15 minutes to get one sounding in depths of over 20 fathoms with a hand lead, and 2 or 3 minutes in depths of from 5 to 6 fathoms. The old methods of lead sounding only touch isolated points in the welter of sand waves and gullies on the sea bottom, and leave an enormous part of the area completely unknown. The echo sounder makes a decided advance on these methods at one stride. It is independent to a great extent of both speed and depth, and it enables an intimate trace of the profile of the bottom to be produced.

Echo sounding depends not only on the speed of sound, but on the power of certain substances to reflect the sound. Full reflecton of sound is obtained when the alternative medium is highly resistant as compared with the first, or when the alternative medium has a very low resistance as compared with the first. The acoustic resistance of various substances has been determined, and it is therefore possible to say what degree of transmission and what degree of reflection will apply in a particular instance. For example, in sound passing from water to steel, the efficiency of transmission is about 13 per cent., whereas in passing from water to air, only a little more than 0·1 per cent. is transmitted. This at once illustrates a practical difficulty in all echo sounding—that the presence of air under an oscillator completely blanks the sound. This phenomenon is known as "aeration," and is one of the most serious difficulties of the echo sounding engineer. On the other hand, the presence of air in the water on a path from the oscillators and in small quantities will give a perfectly distinct echo. Thus it is possible to find shoals of fish. The phenomenon also accounts for the presence of double and treble echoes, and sometimes more, owing to the perfect reflection of the sound from the surface of the sea, or shall we say, from the "under surface" of the atmosphere.

Characteristics of Sound Waves.

	Scales for ether.		Undulations in water and air.				
	Frequency $N=\frac{1}{T}$ per second.	Period T.	Water. $V=\begin{cases}1500\text{ met. sec}\\4920\text{ feet sec.}\end{cases}$ $\gamma=V\,T$	Air. $V=\begin{cases}340\text{ met. sec}\\1115\text{ feet sec.}\end{cases}$ $\gamma=V\,T$			
					Infra sounds		
Theoretical	10	0·1 sec.	150 met.	34 met.	Audible sounds lower limit		
	16	0·063	94	21	Do_2 or C		
	27	0·037	56	13	Lowest piano note		
	64	0·0156	23	5·3	Bass		
	435	0·0023	3·4	0·78	La_2 or A		
	500	0·0020	3·00	0·68	Spoken tones	Human voice	Musical waves
	800	0·0016	2·36	0·54			
	1,024	0·00098	1·47	0·33	Soprano		
	2,048	0·00049	0·76	0·17	Highest soprano (Lucrezia Agujari)		
	4,700	0·00021	0·32	0·07	Fife		

Audible sounds or acoustic waves

Under Investigation, 1st Zone, Promising Field for New Inventions.

Radio, audible only when interrupted	10,000	0·000100	Maximum obtained			
	12,500	0·000080				
	20,000	0·000050	Maximum used practically			
	38,000	0·000026	0·04	0·009	Audible sound upper limit	
	40,000	0·000025	0·038	0·0085		
Inaudible frequencies, audible only when interrupted					Practical ultra sound (not audible)	Ultra sound or ultra sonic wave
			0·015	0·0034		

To summarise then, first, the main principle of echo sounding consists of making a sound and timing the interval between the transmission and the reception of the echo; secondly, the speed of sound in salt water is approximately 4980ft. per second; thirdly, almost perfect reflection is obtained from a layer of air, and, by contrast, practically no transmission is possible for a sound wave passing from water into air; and, finally, the transmission efficiency through steel is about 13 per cent.

The first systems of making a sound were by using an explosive for the transmission, and receiving the echo aurally by a microphonic receiver, the time interval being taken by a chronoscope. This method was, of course, of the sonic order of frequency, and was somewhat crude and slow; that is to say, a considerable time interval was necessary between soundings. A later method, still using the sonic range of frequency, was to strike a diaphragm with a hammer. The hammer was held off the diaphragm by a solenoid against the pressure of a spring. At the moment of transmission the solenoid current was cut off, the spring forced the hammer forward, striking a sharp blow on the diaphragm, by which time the solenoid current was again switched on, so that the hammer returned to its position off the diaphragm. The magnetic hammer system was adequate for moderate depths, or for ships having low speed, but was not sufficiently powerful for great depths and high speed. This led to the introduction of the pneumatic hammer, which admits of a pressure of 100 lb. per square inch, driving the hammer to make its blow. The diaphragm (Fig. 1) is a very carefully sonically balanced rod, and the hammer works inside the rod. The effect of the blow is to set the rod in oscillation, and the frequency of the oscillators is determined by the proportions of the rod. The frequency used is about 1250 cycles per second. When the transmission signal is made, an electric current passing round a coil operates a small valve, admitting air pressure to the hammer. Thus the consumption of electricity is very much smaller than in the magnetic hammer, while the blow struck is much stronger, and is also productive of a tuned note. Another system of oscillation on the sonic range of frequencies is that known as the "Fessenden." Here a diaphragm of comparatively large diameter is vibrated by a magneto-electric system at a frequency of from 1500 to 2000 cycles per second. The frequency is determined by the current oscillation, and

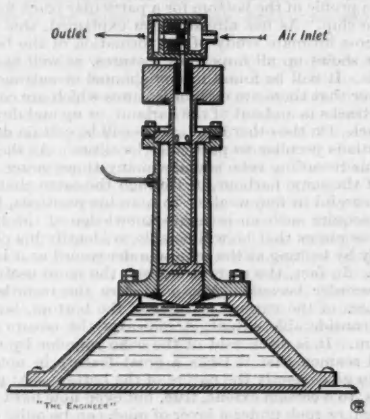


FIG. 1—*Section of Pneumatic Hammer Transmitter.*

the signal is sent out immediately the alternating current operating the oscillator is switched on.

RECEIVERS.

So far transmitters only have been considered, but in all the above instances the sound returning to the ship is received by one form or other of hydrophone, which consists of a tuned diaphragm with a microphonic receiver attached, illustrated in Fig. 2. The returning waves of sound agitate the diaphragm, and thus set up a current of varying intensity, which can be transformed into sound appreciable by the human ear, or as has been done recently, caused to make a suitable mark against a scale in some form of indicator or recorder.

All forms of sonic receiver are affected by other noises than the echo, and the actual original sound will operate the receiver hydrophone directly as well as subsequently by means of the echo. Hence the transmitter and receiver must be separated by such a distance that the direct action does not eliminate the echo. The athwartship separation is as much as the ship will allow, but in the fore and aft direction the separation is usually as much as 50ft. or 60ft. It is usual to put the hydrophone forward,

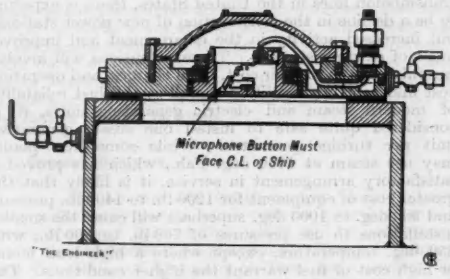


FIG. 2—*Section of Hydrophone.*

as it is less affected by ship noises, water noises, and aeration. It is obvious that with this separation, the depth scale as it approaches zero must become very compressed and hard to read just when precision is wanted, so that the system is of little use in shallow water.

The advantage of the sonic system is its penetrative power, so it is still used for deep-water sounding or in survey ships.

Its disadvantages are:—

(1) It cannot get soundings very close to the bottom of the ship.

(2) It is complicated, and the fittings in the bottom of the ship require a certain amount of attention.

(3) It makes a noise that can be heard in the ship, and it is affected by ship noises.

However, it is not necessary to use noises of the sonic range exclusively, and we can, by passing into the supersonic range of frequencies, avoid most of these disabilities at the price of penetration. The ordinary ship does not require to sound in depths of thousands of fathoms, nor does the surveyor, in his most usual work, consider such depths. Supersonic frequencies attain very high ranges. Broadly speaking, it may be said that the higher the frequency, the less the penetration. This is largely due to the molecular structure which transmits the sound pulses. It is important to remember that it does not matter how big a sound is made, it always travels at the same speed, The first supersonic oscillator was produced by Langevin, using the properties of the piezo-quartz crystal. This oscillator has a frequency of from 30,000 to 40,000 cycles per second, and is the basis of the Marconi "Echometer." Due to its high frequency, it has a low penetrative power, and is useless for deep sounding. It is necessary to place the oscillator outside the hull of a ship, as the plating would absorb the sound. This is effected by cutting a hole, and fitting the oscillator in a strong dome secured to the inside of the plating. It is also necessary that the transmitter should receive the echo, so that in very shallow water, where the bottom is close to the oscillator and the time interval is very small, the transmission interferes with the echo. Thus for great depths and very small depths this system fails. It is, however, quite effective for the ordinary depths required by most ships.

To cover all the requirements of ships it is necessary to find an oscillator having a frequency lying between the piezo-quartz and the hammer. This has been achieved by the Admiralty scientists in making use of the magnetic properties of nickel, and the result is the magneto-striction oscillator. The frequency can be adjusted by the dimensions of the oscillator. If a ring or annulus of the metal be considered, then the natural period is directly proportional to the diameter of the ring, or, put in another way, the longer the period, the greater the diameter required and the less the frequency. In the standard type of ship oscillator (Fig. 3) a frequency of 16,000 cycles per second has been found to give results covering every

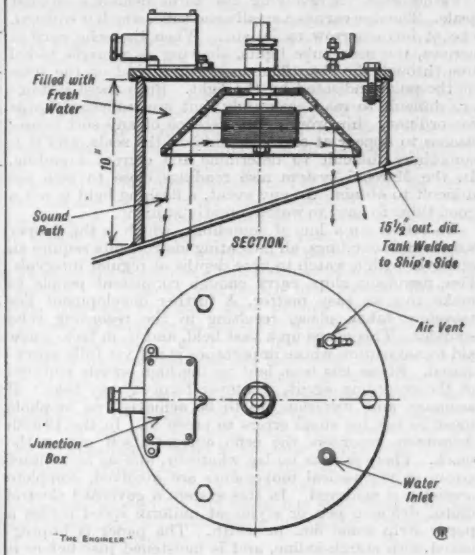


FIG. 3—*Section of Magneto-Striction Oscillator.*

ordinary requirement. In fact, it has great penetrative power, and so not only is capable of sounding to depths of over 1000 fathoms, but also avoids the necessity of cutting the hull plating. The principle of working is based on the fact that nickel alters its length under the influence of a magnetic field. A "pack" of nickel stampings of annular form is wound toroidally by a large-gauge insulated wire. The transmission signal is made by discharging a condenser through this winding. The effect of this is to set up a violent oscillatory current in the winding, which, however, is speedily damped out. The current has set the nickel pack into vibration, and these vibrations, at 16,000 cycles per second, are passed to a reflector and there diverted into a beam having a half-angle of about 21 deg. round a vertical axis. The condenser is originally charged by an inductive charger, and the charge is renewed between signals. Thus the process is repeated for each sounding. For reception, the converse process takes place, with the proviso that the nickel pack is first "flashed," or magnetised. The returning pulses of the echo set up vibrations in the nickel and an oscillating current is induced in the winding. This current is passed through an amplifier, and so to the indicating or recording agent in the instrument on the bridge.

Being supersonic the magneto-striction oscillators are not affected by ordinary noises, and they make practically no noise at all. Nothing can be heard except a slight click. Further, the supersonic noise is not as easily conducted through the steel of the hull, so that these oscillators can be placed comparatively close together. At once several practical advantages appear:—

(1) Both oscillators can be placed in the same compartment of the bottom.

(2) Once fitted, there is nothing to look after.

(3) The oscillators being close together, the depth can be measured close to the bottom without undue compression of the scale.

(4) Soundings can be taken much more rapidly.

TIME MEASUREMENT.

In measuring the time taken for the signal to return, we are dealing with fairly high speeds. An echo-foot occupies $1 \div 2490$ second; 5 fathoms takes $1 \div 83$ second.

* The Institution of Engineers and Shipbuilders in Scotland. Abridged.

This means, when considering the size of the divisions of the scale, that the indicating pointer or the recording pen must travel over the agreed unit distance for, say, 1 fathom, in 1÷415 second. The size of division and the scope of the scale determines the recording speed. To give a scale of, say, ½in. = 1ft. on a 0 to 40ft. scale means that the pen has to travel at a linear speed of 26ft. per second, and this must be done rigidly, precisely, and consistently. The essential part, therefore, of the bridge instrument is the governor controlling the driving motor of the gear. Fortunately, the gear is very easily time-checked, and the adjustments can be very easily made—at any rate, in the British Admiralty machines. In very deep water a small error in depth may result in the lag in time taken to build up a sufficient pulsation in the amplifier to indicate. This may amount to 1ft. in 100 fathoms. Otherwise, provided the indicating or recording speed is correct, the sounding must be correct.

The first method of working was to run a graduated disc at constant speed, and so adjust it that the zero on the disc was opposite a pointer as the signal was made. The operator wore headphones and listened for the echo, at the same time watching the disc and noting the figure opposite the pointer as he heard the echo. The method is simple, and very good, but it requires practice and good hearing, and, of course, concentrated attention. To eliminate the difficulties of having to be practised and to concentrate—undesirable for a lone watch officer with many other things to look out for—various forms of indicator were produced.

The Hughes indicator uses a revolving wheel, carrying coils, and rotating at constant speed. The echo current is passed through the coils, and pulls an armature into their magnetic axis. The magnetic axis is in line with zero when the signal is made, so that the angular distance travelled by the wheel is a measure of the depth. The armature has a pointer on the same spindle, which indicates the depth against a clearly divided scale on the front of the instrument. Several makers favour a very pretty system of flashing lights. The Marconi Echometer, for instance, has a revolving mirror, reflecting a light; as the signal is made, the light flashes along a straight scale, and as the echo current arrives a small electro-magnet cants the mirror, causing the light to make a little "peak" or flash up. The effect is a thin line of light, with a peak opposite the sounding on the scale. In the "Fathometer" a revolving disc turns behind a circular scale. The disc carries a small neon tube, which is covered, except for a narrow radial slit. When the echo current arrives, the neon tube lights, showing as a bright radial line through the slit. The sounding is read on the scale at the point indicated by the light. Both these systems are difficult to read accurately, but are sufficiently near for ordinary ship work. Interference of any sort causes flashes to appear at several points on the scale, and it is sometimes difficult to determine the correct sounding. In the Marconi system also readings close to zero are difficult to obtain. In any event, a flashing light is not a good thing to have to watch intently at night.

To follow up a line of soundings, which is the proper way to use soundings, all indicating instruments require an observer with a watch to note depths at regular intervals. Few merchant ships carry enough competent people to make this an easy matter. A further development has therefore taken place, resulting in the recording echo sounder. This opens up a vast field, and is, in fact, a new aid to navigation whose importance is not yet fully appreciated. Stress has been laid on the high speeds required of the recording agent, whatever form it may take. If accuracy and precision are to be achieved, no loophole must be left for small errors to creep in. In the British Admiralty recorders the echo current itself makes the mark. There is thus no lag whatever, and as no contact errors or mechanical movements are involved, complete precision is achieved. In this system a governed electric motor drives a pen or stylus at uniform speed across a paper strip some 6in. in width. The paper is impregnated with starch-iodine, and is moistened just before it comes under the path of the stylus and lies against a metal plate forming the recording table. The stylus is in contact with the paper during the whole of its passage. The echo current passes from the amplifier to the stylus, and thence through the iodised paper to the plate at the back. In its passage it sets free the iodine and makes a brown mark on the surface of the paper. The sequence of events, therefore, is—the signal is made as the stylus is opposite zero; the signal current is passed to the stylus and a zero mark is made; the stylus moves at constant speed across the paper as the sound travels to the sea bed and returns, and the echo current reaches the pen at a point in its travel proportionate to the depth, and makes a second mark; so that the distance between the zero mark and the echo mark measured on the scale is the depth.

There are several recorders on the market, although the Admiralty led the way by years, and is still a long way ahead in design and in the amazing accuracy and range of scales available.

While the first Admiralty recorders used a straight-line movement for the stylus and reciprocating action, it was found that, to meet the demand for more and more open scales, which the electro-chemical method of recording made possible, stylus speeds would be too high for the reciprocating motion to be retained with safety. This led to the development of the revolving arm design. In all other respects the system is the same. The revolving arm has a radius of 9in., so that the curvature of the stylus path is comparatively slight. This instrument has great precision, and a scale of 0 to 40ft. is in use successfully. It is sometimes used in boats with the oscillators hung outboard. They are mounted in a streamline form, and offer very little additional resistance. By this method, soundings can be taken up to the bottom of the boat to an accuracy of 3in. Three echo inches take one ten thousandth of a second.

A smaller edition of the revolving arm machine has been produced for use in H.M. ships, and approved by the Hydrographer and the Director of Navigation. It is called "Universal," as it is intended to be equally useful in merchant ships and warships. This little recorder is only 16in. in height, 11in. in width, and 11in. in depth. It has a two-speed gear, so that in open water it takes soundings in fathoms, and when the ship enters pilotage waters, it can take soundings in feet. All Admiralty recorders can use a "phasing" system, by which they retain a convenient open scale, but they can increase the range of that scale by steps of "phasing." An Admiralty reciprocating recorder was in use in the search for the "Lusitania," and successfully plotted the outline of the ship at a depth of 48 fathoms.

The real value of the recorder to the sailor is that it gives a profile of the bottom for a particular track followed by the ship. As has already been explained, this profile is a most intimate study of the formation of the bottom, and it shows up all important features, as well as minor details. It will be found in any channel or entrance to a harbour that there are certain features which are common to all tracks in and out of the harbour, or up and down the channel. On the other hand, there will be certain detailed formations peculiar to particular localities. As the sailor uses his recording echo sounder many times going in and out of the same harbour, or through the same channel, if he is careful in fine weather to note his positions, he will soon acquire such an intimate knowledge of the bottom in those places that he will be able to identify his position merely by looking at the echo sounder record as it is being made. In fact, the more it is used, the more useful does the recorder become. Not only does the recorder give the form of the various features of the bottom, but, to a very considerable extent, it indicates the nature of the bottom. It is often said of the echo sounder by experienced seamen that it lacks a great feature in not being able to give exactly the nature of the bottom. At present this is, to a certain extent, true, but even now hard or soft bottom, or rock under a layer of mud, can be quite clearly discerned, and there is very little doubt that in a few years' time, when more experience has been gained with the instrument, this disability will almost completely disappear.

It is evident that echo sounding has by no means reached finality. An efficient machine has been produced, and it now remains to learn how to analyse and make use of the information the machine gives. At the same time, echo sounding may be said to have passed out of the purely experimental stage, and can now be accepted as a definite and most valuable adjunct to the mariner's equipment.

American Engineering News.

An American Diesel-electric Locomotive.

ALTHOUGH it met with ill luck on its second trip of 2230 miles, the 250-ton, 3600 h.p. Diesel-electric locomotive of the Atchison, Topeka and Santa Fe Railroad has proved its practical efficiency in hauling regular trains of 720 tons at high speeds. The engine consists of two duplicate units coupled together, but operated as one machine, and having a control cab at each end. It is 128ft. long, 9ft. 10in. wide, and 14ft. 3in. high. Its tractive force is 120,000 lb. at starting, and 20,000 lb. at 60 miles an hour. The eight axles in the four bogies are all driven by motors. All wheels are 3ft. in diameter, with bogie wheel base of 8ft. 6in., and a spacing of 40ft. between bogie centres of each unit. Over each bogie is a 900 h.p. V-type, twelve-cylinder, high-compression, two-cycle oil engine, with cylinders 8in. by 10in. The welded steel crank case is stronger and lighter than the usual cast iron bed-plate, and the engines weigh less than 20 lb. per horse-power. The cylinders have removable heads and liners, while unit-injection valves assure complete atomisation of oil in the cylinders. The engine speed is 750 r.p.m. Each cylinder has its own exhaust pipe to a silencer or muffler in the roof. Each engine is coupled to a generator supplying current to the two motors on the bogie axles. The locomotive is streamlined for appearance. There is in each unit a boiler for steam heat for the train, and a six-cylinder Diesel engine of 90 h.p. to drive the air compressor, battery-charging generator, and motor blowers of the cooling system. Also, a thirty-two-cell storage battery for engine starting, control of operation, and all auxiliaries, such as the fuel pump, boiler motors, and lights. Besides the air horn, there is an electric siren. On the first run, from Los Angeles to Chicago, 2230 miles, with eleven regular stops, the speed averaged 65 miles an hour, with a maximum of 98 miles an hour. This was with a regular train. On the return trip, fire started in the first unit, and the train was backed to a division point where the locomotive was detached, a steam locomotive taking its place. Nobody was injured seriously, but the cause of the fire has not yet been determined.

Steam Power Plant Developments.

With the increasing extent and linking up of transmission lines in the United States, there is expected to be a decline in the construction of new power stations, but increased activity in the enlargement and improvement of existing stations. These extensions will involve careful study as to their cost, fixed charges, and operating cost and economy. With the well-established reliability of modern steam and electric generating units, it is considered quite safe to install one steam generating unit per turbine generator. While some new plants may use steam at 1000 deg. Fah., which has proved a satisfactory arrangement in service, it is likely that the greater cost of equipment for 1200 lb. to 1400 lb. pressure and 900 deg. to 1000 deg. superheat will cause the smaller installations to use pressures of 700 lb. to 800 lb., with 850 deg. temperature, except where a high load factor or high cost of fuel warrant the higher conditions. The superposition of higher pressures and temperatures and non-condensing turbines on existing plants is attracting increased attention, but plants less than ten years old do not offer much scope for higher economy in this way, while those as much as twenty or twenty-five years old are in a similar condition because of obsolescence and inefficiency of old equipment. Superposed pressures of 650 lb. to 800 lb., with 800 deg. to 850 deg. temperature, are for plants of less than 30,000 kW and 200 lb. pressure. For larger plants, with 400 lb. pressure, the superpressures are 1200 lb. to 1400 lb., with 900 deg. to 950 deg. temperature. But with such superpressures and temperatures, careful attention is required in the treatment of feed water and eliminating moisture carried over in the steam to the superheaters. In the turbo-generator units, these pressure and temperature developments may necessitate changes in shell design. Units running at 3600 revolutions are in demand, and are being supplied in sizes up to 62,500 kVA. In furnaces, water-cooled bottoms and walls are in favour with pulverised coal, and it is considered that higher rates of continuous steam generation are being obtained with pulverised coal than with automatic stokers. The mercury vapour turbine, already in operation at three plants, is a potential line of development for further economies.

Chicago River Control Works.

Although this river is small and short, it is a part of, or the scene of, some important engineering works. As it passes through busy sections of the City of Chicago, U.S.A., it was for many years an outlet sewer, discharging into Lake Michigan. But the city's water supply is drawn from the lake, and with increasing pollution, winds, and currents drifted this pollution dangerously near the waterworks intakes, about a mile from shore. This led to the bold scheme of a canal from the head of the river through the divide to connect with a tributary of the Mississippi River, thus reversing the flow and causing water from the lake to flow "up" the Chicago River and carry the sewage to the Mississippi. This, however, affected the regimen of the lake and after many years of controversy and court trials, the city has been required to greatly curtail the draught from the lake—to 1500 cubic feet per second—and to provide extensive works for the treatment of its sewage instead of discharging it into the river. Another problem has arisen, in that heavy and continued rains are likely to flood the river and cause it to flow to the lake again, thus endangering the water supply. Lowering the bear-trap dam and gates at the inland end of the river will not influence the flow quickly enough to prevent this temporary reversal of the current. To meet this condition, it is proposed to establish a lock and control gates at the mouth of the river. The lock would be 650ft. long, 110ft. wide, and 27ft. deep on the sills. But navigation interests and owners of warehouses, grain elevators, &c., along the city part of the river object to such works, although the gates would be closed only rarely and in times of heavy storm flow. An alternative plan is to establish commercial harbour facilities on the lake front, contiguous to the mouth of the river, and to convert all the present numerous drawbridges into fixed bridges, providing only for barge navigation in the river. A small lock would then suffice. This also is objected to by vested interests, and would cost about £1,000,000, as compared with £200,000 for the control works. Whichever plan is approved by the Government engineers having supervision over navigable waters, the financial problem will still have to be faced.

LAUNCHES AND TRIAL TRIPS.

POMEROON, motor ship; built by Ferguson Brothers (Port Glasgow), Ltd.; to the order of Flannery, Baggallay and Johnson, Ltd.; dimensions, 125ft. 9in. by 29ft. by 10ft. Engines, two four-stroke cold-starting 'airless-injection, compression-ignition. oil engines; constructed by Davey, Paxman and Co., Ltd. Launch, January 8th.

DILWARA, twin-screw motor vessel; built by Barclay, Curle and Co., Ltd.; to the order of the British India Steam Navigation Company, Ltd.; dimensions, 490ft. by 63ft. by 35ft.; to carry troops. Oil engines, Barclay Curle-Doxford type, 560 mm. diameter and 1680 mm. stroke; constructed by the builders. Trial trip, January 16th.

HOPESTAR, steamship; built by Swan, Hunter and Wigham Richardson, Ltd.; to the order of the Wallsend Shipping Company, Ltd.; dimensions, 410ft. by 57ft. 3in.; deadweight carrying capacity, 9800 tons. Engines, Parsons Simplex turbine unit; constructed by the Parsons Marine Steam Turbine Company. Launch, January 22nd.

BELOMORCANAL, steamship; built by the Furness Shipbuilding Company, Ltd.; to the order of the Machinormpost Central Corporation; dimensions, 321ft. 6in. by 48ft. by 22ft. 9in.; to carry timber. Triple-expansion steam engines; constructed by the North-Eastern Marine Engineering Company, Ltd. Launch, January 23rd.

FORT TOWNSHEND, steamship; built by the Blythswood Shipbuilding Company, Ltd.; to the order of the Furness Red Cross Line; dimensions, 326ft. by 45ft. by 27ft. 3in.; to carry passengers and cargo. Triple-expansion inverted direct-acting surface-condensing engines; constructed by David Rowan and Co., Ltd. Launch, January 23rd.

DUNNOTTAR CASTLE, twin-screw motor ship; built by Harland and Wolff, Ltd., to the order of the Union-Castle Line; dimensions, 560ft. by 71ft. 6in. by 35ft.; to carry passengers and cargo. Diesel engines of Harland-B. and W. type; constructed by the builders; launch, January 25th.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

HEAD, WRIGHTSON AND CO., Ltd., Thornaby-on-Tees, have received an order for a swing bridge for the Junagad State Railway, India.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

ASBESTOS AND ENGINEERING PRODUCTS, Ltd., London, E.C.2, informs us that Mr. Basil Heastie, M. Inst. C.E., M.I. Chem. E., has joined the board of the company. Mr. Heastie has had a long connection with the design, fabrication, and operation of chemical plant for the food, chemical, and allied industries.

THE BRITISH (GUEST KEEN BALDWINS) IRON AND STEEL COMPANY, Ltd., has changed its name to Guest Keen Baldwins Iron and Steel Company, Ltd., by special resolution of the company, passed at an extraordinary general meeting held on January 13th, 1936. All contracts and engagements entered into by the company remain in full force and effect, notwithstanding the change in title.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The International Steel Trade.

Since the commencement of the year a change for the better has occurred in the position of most of the Continental steel industries; but it is noticeable that in practically every case this has been due to the improvement in the demand from the domestic markets. In this country, as is only natural, there has been some interruption to trade this week, but in any case the overseas business transacted during January has not fulfilled the expectations entertained at the end of last year. It is probable that buyers abroad will wait for a time until they see how the British steel makers' central selling arrangements operate, but apart from that many of the export markets seem under no necessity to buy for the time being. The scarcity of business from India has aroused some attention, and it has been suggested that a certain amount of trading has been done direct between Indian buyers and Continental steel works. So far as can be gathered, however, the business taken by the Continent from the Indian market this year has not been more than normal. The devaluation of the Belgian currency has created an active demand in the Belgian home market, but it is feared that prices will be advanced owing to the increased costs of fuel and to the demand on the part of the Belgian steel workers for higher wages. The protest of the Cartel to the Belgian Government to the effect that merchants in that country favoured by the devalued franc were buying material ostensibly for export to markets in which cheap prices ruled, and were diverting the shipments to high-priced markets, appears to have had some effect. Although no official action has been taken, there seems to be less of this kind of trading going on. The Belgian Government, however, does not appear inclined to take any effective steps to make the practice illegal. In France, Government and municipal enterprises have greatly improved the domestic demand for steel. In Germany, some anxiety is felt regarding the position of the steel market, and it is said that the stocks are between 150,000 and 200,000 tons short of the usual reserves at this season. A stringency is reported to be developing and constructional and building work is said to be held up through the inability of the manufacturers to give delivery of the necessary steel materials. This week the Continental Cartel by agreement with the British makers released 10,000 tons of bars and sections (excluding joists and plates) for the British market. The irregularity with which Continental material has been allowed to enter this country has caused considerable dissatisfaction and it is understood that efforts will be made to give more regular deliveries in the future. For the latest release the basis price of bars and sections has been increased about 3s. to £5 9s. paper f.o.b. for all British districts. This works out at a delivered price of £7 5s. for London and £7 12s. 6d. for Birmingham. The sizes of bars and sections to which the British steelmakers rebate scheme applies will continue to be sold at £5 2s. 6d. f.o.b.

The Pig Iron Market.

Although the uncertainty regarding the coal outlook has been removed the period of national mourning through which we have been passing has had a restraining influence upon trade. At such times there is always a tendency for new business to be postponed and this gives an appearance of hesitation to the market. The coal dispute, of course, exercised an unfavourable influence on the position. Not only were the makers reluctant to enter into forward commitments until the outlook was clearer, but it is understood that the starting up of additional furnaces was held up for this reason. On the North-East Coast the prices of Cleveland foundry iron are practically nominal, so small has been the amount of new business transacted. The stocks in this district have been low for a long time, but lately they have been drawn upon rather heavily in order to fulfil existing contract requirements. No export business is being transacted, and some nervousness apparently exists as to the possibility that old-established connections may be lost under the existing conditions, and this provides another reason for increasing the production so soon as the outlook warrants it. In the Midlands interest is chiefly centred upon the volume of specifications reaching the makers. It is believed that the January deliveries will show an increase over those for November and December. The possibility of an advance in the prices of Midland irons taking place this week is being discussed, but whilst it is thought that the situation would justify the makers raising their quotations, it is understood that the authorities are averse to a general price increase at the present moment. One of the more favourable developments of late has been a considerable increase in the demand for forge iron. In Lancashire new business is chiefly confined to contract renewals, and the producers, except in special circumstances, avoid taking new forward business. Production in Scotland has been maintained at a steady rate, and it is expected that it will be increased shortly. Business in hematite iron has been rather restricted, but heavy deliveries continue to be made to the steel works in Scotland, the Midlands, and South Wales. A little export business has been done in this market, principally by merchants who have old contracts to draw against. In most districts, however, stocks are being reduced, and stringent conditions seem likely to develop in the market.

Scotland and the North.

The Scottish steel market has not yet recovered the activity which prevailed immediately before the holidays, but this is largely ascribed to the influence of the coal dispute. Now that this trouble has been settled it is expected that the demand will rapidly expand. The shipbuilding industry is in a strong position and is taking a heavy tonnage of plates and sections. The Scottish constructional engineers also are busy, and their requirements are on a considerable scale. Conditions in the general engineering trade were for some time rather erratic, but the industry is now enjoying a spell of activity and is absorbing fair quantities of steel. There has been a slight improvement in export business of late, principally with Empire countries, the two best markets being Canada and South Africa. The recent orders for locomotives, wagons, and other material from the home railways have provided a considerable amount of work for the manufacturers of rails, axles, and tires. The locomotive builders also are absorbing a better tonnage of boiler plates than has been the case for months past. The Scottish sheet makers are well employed, and lately the demand has shown signs of expanding. The motor car manufacturers are not buying so much material as a week or two ago, but the sheet mills have in hand a heavy tonnage for delivery to this industry. The re-rolling works are maintaining a steady output, and owing to the cessation of competition from firms outside the Association they have booked during the past month or two substantial orders for bars and sections. In the Lancashire market new business has been rather erratic, and until the coal dispute was settled there was a tendency to mark time. New business in structural material has been rather quiet, and the specifications reaching the works have also declined in number. In this district considerable interest is taken in the operations of the price-control scheme which has been put into operation by the Constructional Engineers' Association. Although it has been working for some months, the quotas for the various firms have not yet been established. The capacity of the Lancashire constructional works is far in excess of local requirements, and it is argued in some quarters that the fixed price scheme prevents contracts being secured outside the district, particularly in the Midlands and the South. On the North-West Coast the works are well employed, and there is enough work in hand to maintain the present rate of operations for some months.

The Midlands and South Wales.

Business conditions in the Midlands could scarcely be more satisfactory from the point of view of the manufacturers. In some cases consumers are complaining that deliveries are falling into arrears, and, of course, this has been so for the past two or three months in the semi-finished steel department. Billets in particular are in short supply, and lately the increased demand for steel sheets has caused a growing tightness in the market for sheet bars. The prices of this latter material vary somewhat, but the general quotation may be called £5 12s. 6d. to £5 15s. The tendency, however, is for this quotation to advance. Lately, the plate mills, which have been short of orders, have received a welcome tonnage of new business from the shipyards. There is an improvement in the demand for boiler plates, also, resulting from the recent orders given out by the railway companies for locomotives. A feature of the situation in the Midlands is the large volume of work resulting from the erection of and additions to existing factories and workshops. Developments in this direction have supplied, and continue to supply, the constructional engineers with plenty of work, and are reflected in a steady volume of orders for structural steel, with which the mills are finding it difficult to keep pace. The re-rollers are in a comfortable position, and there is practically no price cutting now that the principal outside concerns have agreed to observe the associated works' prices. The quotations may be called £8 d/d for reinforced concrete steel bars up to £8 12s. 6d., less rebates of 2s. 6d. to 5s., for the better class bars. A satisfactory feature of the situation during the past fortnight has been the improvement in the demand for iron bars. This has been largely for the better class bars; but it has also extended to the commoner descriptions. Quotations are £12 at works for marked bars, £9 12s. 6d. for Crown bars, and £7 17s. 6d. and £8 7s. 6d. for No. 3 and No. 4 bars respectively. On the whole, the situation in the South Wales market is satisfactory, and although the tin-plate works are largely debarred by their arrangement with the International Association from taking foreign business, the home demand has expanded to such an extent that they are in a fairly comfortable position. The percentage of production permitted by the Pool has been increased from 55 to 60 per cent., but lately the sales have been rather less than the output. It is said that the increase in the home demand is due to the increased activity at the British canning factories.

Current Business.

The London and North-Eastern Railway Company will shortly put in hand work on a further twenty locomotives and 225 vehicles, which will be constructed under the Government's assisted loan. Head, Wrightson and Co., Ltd., of Thornaby-on-Tees, have secured an order for a swing bridge for the Junagad State Railway of India. The Scottish Pig Iron Trade Board announces that the certified returns for October, November, and December, 1935, show an average net selling price of £3 5s. 7d. per ton. There will be no change in the basis rates of wages on these figures. Colvilles Ltd. have secured a contract for the supply of 20,000 steel sleepers to the Canton-Hangkow Railway from the Chinese Government Purchasing Commission. A 12in. guide and merchant mill which formed part of the Pather Iron and Steel Works, Wishaw, is being dismantled by the Motherwell Machinery and Scrap Company, Ltd. The mill is to be re-erected and operated near Manchester. Hurst, Nelson and Co., Ltd., Motherwell, have secured an order for fifty 12-ton wagons from Charrington, Gardner, Locket and Co., Ltd., London. The Brynymor Steamship Company, Ltd., Swansea, has ordered a cargo steamer of 9500 tons deadweight from the Burntisland Shipbuilding Company, Ltd. The Department of Overseas Trade announces that the following contracts are open for tender:—Iran, Kampsax Consortium: supply and erection of steel oil tanks, electric pumps and vertical boiler (Teheran, February 13th); South African Railways and Harbours Administration: two 5-ton and two 10-ton electrically driven overhead travelling cranes for iron and brassfoundries, Salt River workshops (Johannesburg, February 24th); New Zealand Public Works Department: supply of pumping sets for cooling water for Arapuni Power Development (Wellington, April 14th); Argentine State Railways Administration: supply, erection, and painting of a steel span, bearers, and accessories for a bridge (Buenos Aires, February 27th). Argentine State' Oilfields Directorate: Construction and equipment of an electric generating station at the storage depot at San Lorenzo; involving the erection of the building and the supply of diesel-engine driven alternators and associated equipment.

Copper and Tin.

A moderate activity has characterised the electrolytic copper market, but it is not surprising, considering the surrounding circumstances, that the tone has been rather restrained. Towards the end of last week a brisk inquiry sprang up, chiefly from Central Europe, but not all of this materialised into business. Some of this inquiry, it was suggested, resulted from efforts on the part of Italy to obtain supplies. Apparently the Italians are not finding it easy to cover their requirements, since although copper is not upon the prohibited list, the financial sanctions place obstacles in the way of important purchases. The American position does not materially improve and consumers there continue to buy from hand to mouth. It is believed, however, that heavy requirements are being held back from the market owing to the uncertainty felt regarding the consequences of the New Deal legal decisions. Most of the copper consuming industries in this country are in a satisfactory position as regards the work upon their books and are providing a steady outlet for a normal tonnage. The home requirements, however, have not expanded to the extent which was anticipated a week or two ago. American figures give the world's production of refined copper in December as 141,700 tons, the total production for the year being 1,505,000 tons. This includes the production of the United States in December of 59,500 tons and for the whole year of 502,000 tons. Prices in the standard market have been well maintained and there are signs that a bull speculative account is being built up. . . . The tin market has been steadier than for some time and operators seem to hold the opinion that the price is likely to be stabilised at a little above £200. At the same time, it is felt that this situation can only be obtained by powerful interests bolstering up the forward price, and if this is the case it seems probable that there will be no relief from the artificial conditions which have ruled in the tin market for a long period. It is expected that the supplies resulting from the increase in the quota will come to hand in the near future, and, in fact, estimates indicate an increase in the visible supply at the end of January of about 1000 tons. This month the industrial demand for the metal has been disappointing, and neither in the United States nor on the Continent has it developed a healthy tone.

Lead and Spelter.

The lead market has provided some surprises during the past week. On January 23rd the price advanced to the extent of £1; but later there was a small reaction. The movement apparently resulted from the producers adopting a more reserved attitude, with the result that consumers who had been holding off the market bought freely as the price advanced. The fact that most of the high-priced contracts which have been maturing during the past fortnight or so are now out of the way no doubt contributed to the firmer tone of the market. The outlook, however, remains indefinite, and it is probable that this week a certain amount of business will be held up, so that it will be difficult to judge the real situation. Although consumers came into the market last week buying was not sustained. On the other hand, the manufacturers of lead products are busy in nearly every department, so that it is assumed there is still a considerable amount of covering to be done. The situation on the Continent does not seem to be progressing satisfactorily, and whilst there has been a fair amount of buying, the prospects of a strong demand for lead developing do not seem particularly bright. In the United States the position is gradually improving. The American statistics give the stocks of refined lead at the end of the year as 222,300 tons, compared with 222,636 tons at the end of November. The production in the United States last year is estimated at 412,298 tons. . . . The better tone recently noticed in the spelter market has been maintained and prices have slightly advanced over the week. At the same time, no fresh feature of importance has developed in the position, and whilst consumption by some industries is exceptionally good, the quantities taken by the galvanising industry are disappointing. The requirements of the brass trades in this country appear to be growing and substantial quantities of metal are being absorbed by the die castings industry. There have been some arrivals of foreign spelter, mostly Silesian, and further quantities are expected to reach this country before the end of the month. Once more reports are current of efforts to revive the European Zinc Cartel, but these may be treated with reserve, and it is not likely until conditions in the market change that any serious attempt will be made to reconstruct that organisation.

Current Prices for Metals and Fuels.

Makers' official home trade prices per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. * For Markets other than Canada, India, South Africa, Australia and New Zealand 5s. per ton must be added.

PIG IRON.

	Home. (*D/d Teesside Area*) £ s. d.	Export. £ s. d.
N.E. COAST—		
Hematite Mixed Nos.	3 10 6	3 2 0
No. 1	3 11 0	3 3 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 12 6	3 4 0
No. 3 G.M.B.	3 10 0	3 1 6
No. 4 Forge	3 9 0	3 0 6
Basic (*Less 5/- rebate*)	3 10 0	—
MIDLANDS—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 15 0	—
„ „ Forge	3 10 0	—
Basic (*Less 5/- rebate*)	3 15 0	—
Northampton—		
Foundry No. 3	3 12 6	—
Forge	3 7 6	—
Derbyshire—		
No. 3 Foundry	3 15 0	—
Forge	3 10 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 13 6	—
No. 1 Foundry, ditto	3 16 6	—
No. 3 Foundry, ditto	3 14 0	—
Basic, d/d (*Less 5/- rebate*)	3 10 0	—
N.W. COAST—	3 14 0 d/d Glasgow	
Hematite Mixed Nos.	3 18 6 „ Sheffield	
	4 4 6 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
LANCS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. YORKS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
MIDLANDS—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
No. 3 quality	7 17 6	—
No. 4 „	8 10 0	—
SCOTLAND—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. COAST—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

	Home. £ s. d.	Export. £ s. d.
LONDON AND THE SOUTH—		
Angles	8 10 0	*7 10 0
Tees	9 10 0	*8 10 0
Joists	8 17 6	*7 10 0
Channels	8 15 6	*7 15 0
Rounds, 3in. and up	9 10 0	*8 10 0
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¼in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 10 0	9 0 0
NORTH-EAST COAST—	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	*8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
„ under 3in.	8 12 0	7 10 0
Plates, ¼in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	9 0 0
Boiler Plates, ¼in.	9 5 0	—
MIDLANDS, AND LEEDS AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	*8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 5 0	9 0 0
Boiler Plates, ¼in.	9 7 6	7 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
GLASGOW AND DISTRICT—		
Angles	8 7 6	*7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	9 0 0
Boiler Plates	9 5 0	—
SOUTH WALES AREA—	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	*8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 10 0	9 0 0

IRELAND—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

	Home. £ s. d.	Export. £ s. d.
Sheets.		
10-G. to 13-G., f.o.r.	9 15 0	9 0 0
14-G. to 20-G., d/d	11 5 0	9 10 0
21-G. to 24-G., d/d	11 10 0	9 15 0
25-G. to 27-G., d/d	12 2 6	10 7 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24

Home.	£ s. d.
4-ton lots and up	13 10 0
2-ton to 4-ton lots	13 17 6
Under 2 tons	15 10 0

Export: £12 15s. 0d., c.i.f. India.
„ £11 15s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18s. 9d.
Tin-plate Bars, d/d South Wales Works, £5 10s. 0d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 to 250 tons	5 17 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/- per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/-
„ „ 6 p.c. to 8 p.c.	£21 0 0	7/-
„ „ 8 p.c. to 10 p.c.	£21 0 0	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£33 10 0	11/-
„ „ „ 1 p.c. carbon	£36 5 0	11/-
„ „ „ 0·50 p.c. carbon	£37 5 0	12/-
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose), 76 p.c.	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/- p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/- p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, January 29th.

COPPER—		
Cash	£34 17 6 to £34 18 9	
Three months	£35 6 3 to £35 7 6	
Electrolytic	£39 0 0 to £39 10 0	
Best Selected Ingots, d/d Birmingham	£39 5 0	
Sheets, Hot Rolled	£66 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10½d.	10½d.
„ Brazed (basis)	10½d.	10½d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£32 0 0 to £33 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9½d.	9½d.
„ Brazed	11½d.	11½d.
TIN—		
Cash	£207 10 0 to £208 0 0	
Three months	£198 15 0 to £199 0 0	
LEAD	£16 2 6 to £16 5 0	
SPELTER	£15 3 9 to £15 6 3	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

LANARKSHIRE—	Export.
(f.o.b. Grangemouth)—Navigation Unscreened	17/6 to 18/-
Hamilton Ell	20/- to 21/-
Navigation Splints	21/- to 22/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	17/- to 17/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	16/6 to 17/-
Unscreened Navigation	17/- to 17/6
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime	17/6
Secondary Steam	17/-

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	19/6 to 23/-
Furnace Coke	14/6 to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	15/6 to 16/6
„ Second	14/6 to 15/-
„ Best Small	11/- to 11/6
Unscreened	13/6 to 14/6
DURHAM—	
Best Gas	14/8
Foundry Coke	20/- to 23/-

SHEFFIELD—	Inland.	
Best Hand-picked Branch	26/- to 28/-	—
South Yorkshire Best	23/- to 25/-	—
South Yorkshire Seconds	20/- to 21/-	—
Rough Slacks	11/- to 12/-	—
Nutty Slacks	10/- to 11/-	—

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	19/6
Best Seconds	19/- to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Bunker Smalls	12/6 to 13/6
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/- to 27/6
Foundry Coke	27/- to 40/-
Furnace Coke	19/- to 22/6
Patent Fuel	21/-
SWANSEA—	
Anthracite Coals:	
Best Large	36/- to 40/-
Machine-made Cobbles	41/- to 48/6
Nuts	40/- to 48/6
Beans	25/- to 30/-
Peas	19/- to 23/-
Rubbly Culm	11/6 to 12/-
Steam Coals:	
Large Ordinary	18/- to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

French Engineering Notes.

(From our own Correspondent in Paris.)

Motor Car Industry.

THE motor car industry is still suffering from the effects of the financial embarrassments that overtook it two years ago, when some big firms had to be reconstructed with loss of capital and a change had to be made in business methods. The need for economy deprived French makers of publicity through racing and other competitive tests. They failed in international racing events, which enhanced the reputation of foreign cars at the expense of their own. Manufacturers had not the means to design and construct special cars to compete with those of foreign rivals, who experimented with technical innovations that did not benefit the normal construction of motor vehicles. A year ago an appeal was made to the public for subscriptions to enable the industry to build an experimental car that would take part in international racing. The appeal met with hardly any response, and the idea of a national super-racing car was abandoned. Now another effort is being made to meet the difficulty by organising races for cars from which are eliminated special devices, such as superchargers, that are not employed in touring cars. It is proposed that racing cars shall have a maximum cylinder capacity of 4 litres and a minimum weight to be fixed according to the cylinder capacity. Commercial fuels will be employed, as well as the mixture of 64 per cent. petrol, 18 per cent. benzol, and 18 per cent. alcohol, which was the standard fuel for the Grand Prix race in 1930. Racing cars will be debarred from using fuels that are not employed by the ordinary car owner. In a word, the idea is to level the chances of competitors by imposing conditions that will favour technical advance along the lines of normal motor car development, so that all makers will be able to take part in races without risk of failure in competition with cars of a more or less freakish character. It is proposed to organise a Grand Prix race in France according to this formula.

Oil Research.

The Office National des Combustibles Liquides has given an account of oil research covering the whole ground of home and colonial supplies, and while a great deal of activity has been shown in the utilisation of national liquid fuels, the difficulties to be overcome, mainly of an economic character, are retarding progress. The hydrogenation of coal has been started on an experimental scale at two collieries, so that nothing can yet be said about its future in this country. There are extensive shale deposits, but the cost of working them hinders successful development, and the Office National recognises that shale oil cannot be commercialised satisfactorily without fiscal protection. Credits have been granted by the State for work in connection with shale and lignite oils. A mixture of olive oil and mineral oil for lubricating purposes has been the subject of many experiments in Algeria, and it is affirmed that the acidity of olive oil had no effect on the engines lubricated with the mixture, and it only left slight traces on anti-friction metals. The mixture recommended is 25 per cent. of olive oil. The object of these experiments is to find an industrial outlet for the olive oil industry, particularly in North Africa, which is jeopardised by the competition of ground nut oil. So far as concerns boring for oil, results have not been encouraging, except in Morocco, and in view of the publicity given to discoveries in that Protectorate the Office National says that there is at present no ground for undue optimism. The first boring was made at Tselfat in 1931, and in the Gharb a well has been sunk to nearly 10,000ft. Last year the total depth of boring undertaken by the Compagnie Française des Pétroles, in collaboration with the Cherifian Mining Department and the Office National des Combustibles Liquides, had exceeded 31,000ft. In some cases there was a good initial flow of oil, but in a general way the deposits appear to be shallow and irregular. Nevertheless, the known existence of oil over large areas in Morocco encourages boring in the hope of reaching sufficiently big supplies.

Dearth of Mechanics.

The Syndicate of Mechanical Industries, representing employers in the engineering trades, is taking measures to deal with a situation that has long caused trouble to employers who are unable to procure qualified mechanics from the ranks of unemployed men. There are plenty of specialised labourers whose occupations have disappeared since mass production in the automobile and some other industries was abandoned, and so long as these men earned good money without preparatory training, the apprenticeship system fell almost into desuetude. Employers had to rely largely on foreign mechanics, whose places are filled with difficulty now that decrees for the protection of native labour have resulted in the repatriation of foreigners. The syndicate aims at increasing facilities for training in apprenticeship schools, and has obtained promises from some of its members to take on apprentices. This is an important concession in view of the restrictions imposed on workshops where apprentices are employed, and the only advantage accruing to employers is that they are relieved of the special tax which helps to maintain the apprenticeship schools. In the big engineering works there are special shops for apprentices, so that legislation affecting their hours of labour does not interfere with the factory routine, and it is hoped to extend this training to smaller works by the separation of apprentices from shops where such factory restrictions must be avoided.

Franco-British Trade.

An analysis of the trade returns for the past year shows that imports from Great Britain totalled 1579 million francs, as compared with 1643 millions in the previous year, while exports from France to Great Britain increased from 1543 million francs to 1611 millions. The remainder of the British Empire supplied goods, produce, and material to this country to the value of 2065 million francs, as compared with 1924 millions in 1934, and exports from France to the British Empire, excluding Great Britain, amounted to 279,588,000f., as against 314,344,000f. in 1934.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

440,124. August 3rd, 1934.—COMBUSTION CHAMBERS OF COMPRESSION IGNITION ENGINES, Crossley Brothers, Ltd., Openshaw, Manchester, 11, and H. D. Carter.

This arrangement is devised to create considerable turbulence in the combustion chamber at the point of fuel injection. The

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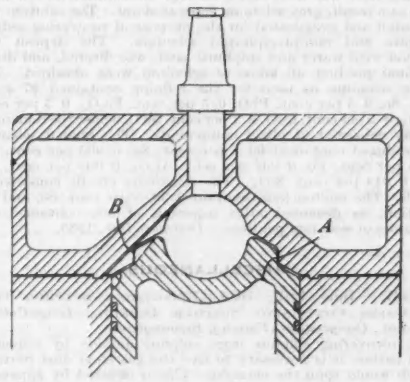

chamber is formed as two hemispheres, one in the cylinder head and the other in the top of the piston. A step is made in the piston and the cover at A. Air is entrapped in the annular space thus formed and highly compressed at the end of the stroke. It is then injected into the combustion chamber tangentially through the passage B.—*December 20th*, 1935.

TURBINE MACHINERY.

439,848. June 29th, 1935.—DOUBLE ROTATION STEAM TURBINES, *H. G. Cruikshank Fairweather*, 65–66, *Chancery-lane, London, W.C.2.*

In turbines of the Ljungstrom or double rotation type, if steam is to be bled off at an intermediate stage, it is generally passed out through holes in the turbine discs. This practice, however, suffers from the disadvantage that it weakens the discs. As a consequence, the inventors adopt the design illus-

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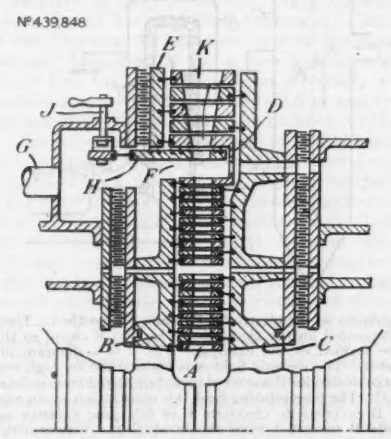


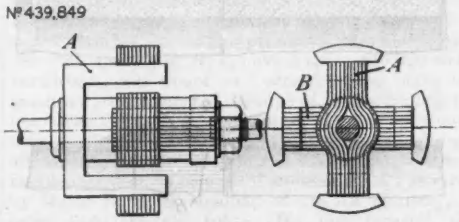
trated. A indicates the normal group of high-pressure blades attached to the two discs B and C. The outermost ring of these blades is extended by the folded back part D, and this carries the annular disc E, which is thus virtually an extension of B, but leaves an opening F through which steam can be bled to the branch outlet G. A sliding ring H, operated by the gear J is used to regulate the amount of steam passing to the low-pressure blades K. The remainder goes to the bleeding branch.—*December 16th*, 1935.

DYNAMOS AND MOTORS.

439,849. July 9th, 1935.—MAGNETOS, J. Bernard, 117, Boulevard Exelmans, Paris, France.

This magneto is specially intended for multi-cylinder internal combustion engines. The drawing shows only the field magnet. It has, in the case illustrated, four poles, but there may be more.

№439,849



The yokes A and B are built up of fork-shaped laminations lying parallel with the axis of rotation. The pole pieces are also laminated, but in this case the laminations lie circumferentially. In this way, it is claimed, Foucault currents in the magnet are suppressed. The rivets used to hold the laminations together are electrically insulated.—*December 16th*, 1935.

TRANSFORMERS AND CONVERTERS.

440,120. July 2nd, 1934.—CONTROL ELECTRODES FOR LOW-PRESSURE ELECTRIC ARC CONVERTERS, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, and E. Gallizia, the General Electric Company, Engineering Works, Witton, Birmingham.

This invention relates to control electrodes for low-pressure electric arc converters. When mercury arc converters are adapted to operate with control electrodes, it is desirable in order to obtain reliable and consistent control that the electrodes should operate in regions that are relatively hot, and an object

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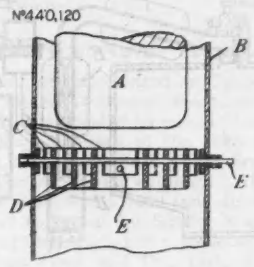

of the invention is the provision of improved electrodes adapted to effect heating of the regions in which they are situated. The anode A is surrounded by the usual anode shield B, supported in any convenient manner from the converter vessel, not shown. The control electrode comprises a series of concentric rings C of metal or graphite and D of quartz. The rings are supported on rods E E, insulated from the anode shield. One of these rods is extended and provides a connection to the supply of control potential. The electrodes not only serve the purpose of controlling the anode current, but also act as de-ionising grids to ensure more efficient control.—*December 20th*, 1935.

TELEGRAPHS AND TELEPHONES.

439,831. June 16th, 1934.—SWITCHBOARD CONDUCTORS, Associated Electric Laboratories, Inc., 1033, West Van Buren-street, Chicago, Ill., U.S.A.

According to this invention electric conductors for telephone switchboard service are insulated by a process which consists in applying to the conductor a layer of fibrous material of the character of artificial silk adapted to become plastic on application of a solvent such as acetone, and then over the first layer

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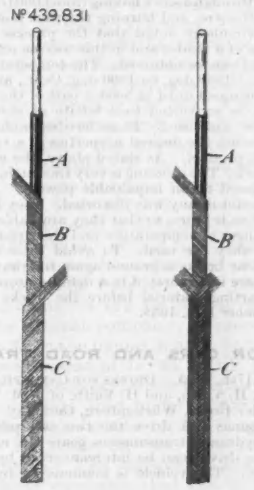

applying a further layer or layers of fibrous material of a substance which is not acted upon by such solvents, and saturating the whole with a solvent for the first-mentioned layer so as to cause a portion of the first layer to become plastic and to intrude between the fibres of the outer layer or layers, the solvent being thereupon evaporated. The wire is first given a coating of enamel A. It is then covered with artificial silk B, and finally with cotton C. It is then passed through a bath of acetone and allowed to dry.—*December 16th*, 1935.

CRANES AND CONVEYORS.

439,694. July 16th, 1934.—GRABS, D. J. Barnard, 8, Strathfield-gardens, Barking, Essex.

The inventor aims at increasing the span of grab buckets

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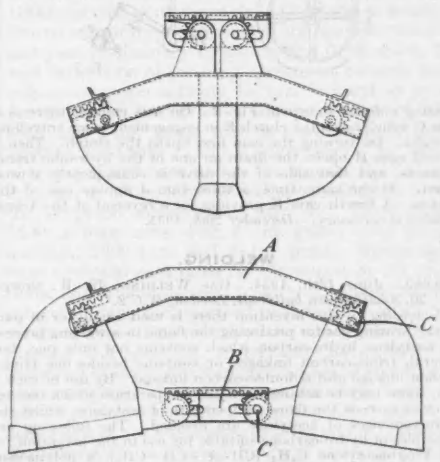
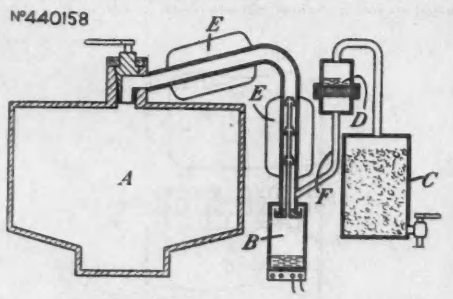


when they are open. So he pivots them to the main frame A and the closing frame B by means of toothed rollers C C. The two illustrations show plainly the action of the grab.—*December 12th*, 1935.

ELECTRICAL APPLIANCES.

440,158. May 27th, 1935.—METAL VAPOUR IONIC VALVES, Allmänna Svenska Elektriska Aktiebolaget, Västeras, Sweden.

This is an arrangement for removing gases which may leak into the vessel of an ionic valve. A is the vessel and B a diffusion pump of normal design. C is a chamber filled with an absorbent, such as bone charcoal. D is a mercury seal, and E E cooling jackets. The connection F rises vertically so that any mercury



vapour drawn over is condensed and flows back to the pump. By the interconnection of such a high vacuum pump, the pressure above the receiving medium in the receptacle C may be allowed to rise to the ordinary counter-pressure of the high vacuum pump—for instance, some tens of millimetres—without impairing the vacuum in the main receptacle A. The receiving faculty of the absorbing or adsorbing medium is thereby very much increased.—*December 20th*, 1935.

FURNACES.

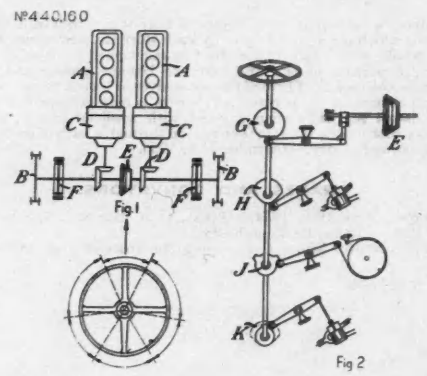
440,010. April 10th, 1935.—THE MANUFACTURE OF REFRACTORY BRICKS, SLABS, AND THE LIKE, J. Ernould, 21, Avenue Foch, Longwy (Meurthe-et-Mosell), France, and Société Des Hauts Fourneaux de la Chiers, Longwy.

This invention relates to the manufacture of refractory bricks, slabs, and the like from lime, and having the colour, appearance, hardness, and most of the properties of magnesia bricks. This new product has a very high resistance to hydration and to temperature. The process comprises moulding under a high pressure (from 300 kilos. to 1000 kilos. per square centimetre or more) and without the use of a binder a mixture of calcined lime and an oxide of iron, chromium or aluminium, the constituents of which mixture are in a state of subdivision fine enough to pass through a sieve having from 6000 to 20,000 meshes per square centimetre, and burning the thus moulded mixture. It is to be particularly noted that the process is carried out without the use of a binder and in this way an extremely homogeneous product can be obtained. The temperature in the kiln is of the order of 1350 deg. to 1500 deg. Cent., and the burning operation is continued until at least a part of the metallic oxide in the mixture is converted to a ferrite or chromite of lime, according to the oxide used. These ferrites or chromites impart to the final product the desired properties of a very high grade basic refractory product. As stated above, the calcined lime is first of all ground. The grinding is very thorough, and the lime is preferably reduced to an impalpable powder. After burning, the articles are not in any way distorted. They have, however, an extremely fine texture, so that they are liable to be affected by sudden changes of temperature and their resistance may be reduced when they are used. To avoid these disadvantages, a portion of these bricks is ground again to granules of suitable size and these are incorporated in a definite proportion into the pulverulent starting material before the bricks are fed to the presses.—*December 18th*, 1935.

MOTOR CARS AND ROAD TRAFFIC.

440,160. June 17th, 1935.—DRIVES FOR CATERPILLAR TRACTORS, W. Voith, H. Voith, and H. Voith, of J. M. Voith, Heidenheim au der Brenz, Würtemberg, Germany.

The two engines A A drive the two caterpillar tracks B B through the hydraulic transmission gears C C and bevel gears D D. The two drives can be interconnected by the clutch E. F F are brakes. The vehicle is manœuvred by means of the



steering column shown in Fig. 2. On this column there is a cam G which holds the clutch E in engagement when travelling straight. On turning the cam first opens the clutch. Then a second cam H opens the drain on one of the hydraulic transmissions, and that side of the drive is consequently slowed down. At the same time, a third cam J applies one of the brakes. A fourth cam K provides for a reversal of the transmission if necessary.—*December 20th*, 1935.

WELDING.

439,689. June 12th, 1934. GAS WELDING, *W. W. Groves*, 30, *Southampton-buildings, London, W.C.2.*

According to this invention there is used wholly or in part as the heating gas for producing the flame in a welding process an acetylene hydro-carbon which contains not only one, but several, triple-carbon linkages, or contains besides one triple-carbon linkage also a double-carbon linkage. By use of such a gas, there may be attained a flame temperature which reaches or even exceeds the flame temperature of acetylene, whilst the inconveniences of acetylene are avoided. The following are examples of hydro-carbons suitable for use in the invention :—(1) Vinyl-acetylene C_4H_4 ($CH{\equiv}C - CH{=}CH_2$), a polymerisation product of acetylene, has a higher heat of decomposition and only a slightly lower flame temperature than acetylene ; it boils at +5 deg. Cent. (2) Diacetylene C_4H_2 ($CH{\equiv}C - C{\equiv}CH$) has a heat of decomposition which is more than twice as great as that of acetylene and a considerably higher flame temperature than acetylene ; it boils at +10 deg. Cent. (3) The pentadiines C_5H_4 ($CH{\equiv}C - CH_2{\cdot}C{\equiv}CH$, or $CH{\equiv}C{\cdot}C{\equiv}C{\cdot}CH_3$) likewise have a very high heat of decomposition and about the same flame temperature as acetylene. They are liquid at room temperature, but can easily be gasified on account of their high vapour pressure. It is, of course, also possible to use mixtures of the aforesaid hydro-carbons either with one another or with other fuels.—*December 12th*, 1935.

METALLURGY.

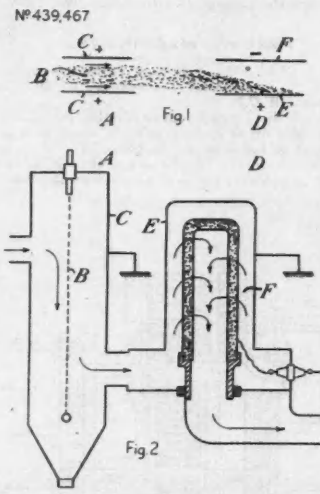
440,004. February 5th, 1935.—REFINING SELENIUM, Bolidens Gruvaktiebolag, Västra Trädgardsgatan 17, Stockholm, Sweden.

In the production of selenium there is generally obtained a product contaminated by iron, lead, copper, alumina, as well as by several other substances. The invention has for its object the production of a pure grey selenium in an economical and technically simple way ; 60 kilos. of sodium hydrate were melted in an iron pot together with 6 kilos. of charcoal and heated to 400 deg. Cent ; 40 kilos. of crude selenium were added successively in small portions whilst stirring, in doing which a vigorous evolution of steam ensued. After three hours, the selenium was entirely dissolved and the evolution of steam had very nearly ceased. The molten mass was dissolved in 400 litres of water and the solution was filtered. Air in a finely divided state was then blown through the solution for ten hours and, as a result, grey selenium separated out. The solution was decanted and evaporated for the purpose of recovering sodium hydrate and non-precipitated selenium. The deposit was washed with water and sulphuric acid, was filtered, and dried. As final product 36 kilos. of selenium were obtained. The crude selenium as used for the refining contained 97·5 per cent. Se, 0·5 per cent. PbO, 0·5 per cent. Fe_2O_3, 0·3 per cent. Al_2O_3, 0·5 per cent. CuO, 0·1 per cent. SiO_2, whilst the remainder chiefly consisted of alkali compounds. The refined selenium as produced contained 99·8 per cent. Se, 0·003 per cent. Pb, 0·05 per cent. Fe, 0·007 per cent. Al_2O_3, 0·006 per cent. Cu, and 0·014 per cent. SiO_2. The remainder chiefly consisted of alkali. The molten mass contained 39·5 per cent. Se, and the solution, as decanted after injection of air, contained 1·5 grammes of selenium per litre.—*December 18th*, 1935.

MISCELLANEOUS.

439,467. June 14th, 1935.—RECOVERING SULPHUR FROM GASES CONTAINING SULPHUR DIOXIDE, *Lodge-Cottrell, Ltd., George-street (Parade), Birmingham.*

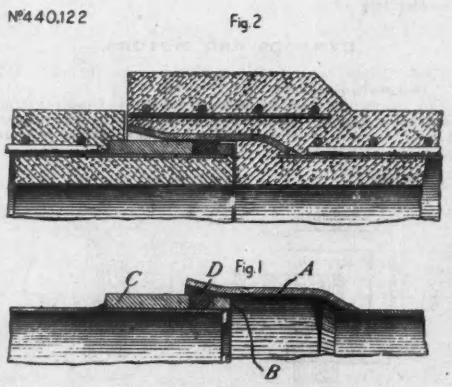
In recovering sulphur from sulphur dioxide by reduction with carbon it is necessary to free the gas from dust particles which would spoil the catalyst. This is effected by apparatus shown schematically in Fig. 1. The gas is passed through an ionising field A constituting high-tension discharge electrodes B and high-tension positive, or earthed, non-discharging electrodes C. The gas then goes on to a precipitating field D comprising non-ionising electrodes. The electrode E is of the



same polarity as the electrodes B, while F is earthed. The dust is all deposited on the electrode E, leaving F clean, so that it may be formed of the catalyst. Fig. 2 is a diagram of the apparatus. The ionising field A is constituted by high-tension discharge electrodes B mounted in and insulated from an earthed casing C. The precipitating field D is constituted by an earthed casing E covering an electrode F of the same polarity as the electrode B insulated from the hood E and constituting the catalyst whose surfaces remain free from dust, while the impurities are deposited on the electrode E, which forms a protective hood for the catalyst.—*December 6th*, 1935.

440,122. July 20th, 1934.—PIPE JOINTS, *A. H. Stevens, of Messrs. Stevens, Langner, Parry and Rollinson, 5–9, Quality-court, Chancery-lane, London, W.C.2.*

This is a spigot and socket joint. The socket is formed by the bell A welded to the end of the pipe. The spigot end has two



rings B and C, tack-welded in place, with a groove between them. In this groove there is placed a rubber gasket D. When the two pipes are pushed together this gasket is said to form a tight joint without further manipulation. It is protected from atmospheric effects by the concrete covering, as shown in Fig. 2. —*December 20th*, 1935.

Forthcoming Engagements.*

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Internal Combustion Engine Group. Informal discussion, introduced by Mr. E. C. Ottaway, on "Service Maintenance of High-speed Internal Combustion Engines for Transport and Power." 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Machinery and Engineering in Ancient Times," Mr. R. P. Howgrave-Graham. 7.30 p.m.

MONDAY, FEB. 3RD.

BRADFORD ENGINEERING SOC.—Technical College, Bradford. "Air Lift Pumps," Dr. J. Ward. 7.30 p.m.

INST. OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, S.W.1. "Developments in Reinforced Concrete Construction," Mr. J. Mason. 6.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. General meeting. 5 p.m.

TUESDAY, FEB. 4TH.

GLASGOW UNIVERSITY ENGINEERING SOC.—James Watt Engineering Laboratories, The University, Glasgow, W.2. "Applications of the Diesel Engine to Road Transport Vehicles," Mr. H. W. Fulton. 7.30 p.m.

INST. OF AUTOMOBILE ENGINEERS.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. "The Evolution of the Small Motor Yacht," Mr. Tom Thornycroft. 7.45 p.m.

WEDNESDAY, FEB. 5TH.

INST. OF CIVIL ENGINEERS : MANCHESTER AND DISTRICT ASSOC.—Midland Hotel, Manchester. Annual dinner. 6.30 for 7 p.m.

INST. OF ELECTRICAL ENGINEERS : WIRELESS SECTION.—Savoy-place, W.C.2. "Electron Optical Systems and their Applications," Dr. V. X. Zworykin. 6 p.m.

THURSDAY, FEB. 6TH.

BIRMINGHAM UNIVERSITY ENGINEERING SOC.—At the University, Edgbaston. Lecture, "Some Aspects of Industrial Installation Work." 5.45 p.m.

INST. OF STRUCTURAL ENGINEERS : S. WESTERN COUNTIES BRANCH.—Technical College, Plymouth. "Welding and Erection of Steel Work for Three-storeyed Building." 7.30 p.m.

FRIDAY, FEB. 7TH.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Education Group. Mr. F. E. Robinson will introduce discussion on "The Training of Craftsmen." 6 p.m.

INST. OF SANITARY ENGINEERS.—Caxton Hall, Westminster, S.W.1. "Difficulties Encountered Owing to the Presence of Water in Sewerage Workings," Mr. H. C. H. Shenton. 7 p.m.

INST. OF STRUCTURAL ENGINEERS : WESTERN COUNTIES BRANCH.—At Merchant Venturers' Technical College, Bristol. "The Reconstruction of Temple Meads Station, Bristol," Mr. John F. Bickerton. 7.15 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Early Windmill Gearing," Mr. Reginald Wailes. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Mining Inst., Newcastle-upon-Tyne. "Friction of Piston Rings," Engr.-Comm. C. J. Hawkes and Mr. G. F. Hardy. 6 p.m.

SATURDAY, FEB. 8TH.

INST. OF MARINE ENGINEERS.—85–88, The Minories, E.C.3. Junior Section dance. 7.30 to 11.15 p.m.

MONDAY, FEB. 10TH.

CHARTERED SURVEYORS' INST.—12, Great George-street, S.W.1. Meeting at 6.30 p.m.

TUESDAY, FEB. 11TH.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Modern Marine Auxiliary Plant," Mr. H. Hillier. 7.30 p.m.

INST. OF MARINE ENGINEERS.—85–88, The Minories, E.C.3. "Notes on the Turbo-electric Propulsion Equipment of the Liner 'Normandie,'" Monsieur E. Roth. 6 p.m.

INST. OF STRUCTURAL ENGINEERS : S. WALES AND MONMOUTHSHIRE BRANCH.—Baltic Lounge, Swansea. "Cinema Theatres," Mr. A. G. Thompson. 7 p.m.

WEDNESDAY, FEB. 12TH.

INST. OF STRUCTURAL ENGINEERS : LANCASHIRE AND CHESHIRE BRANCH.—College of Technology, Manchester. "City Housing," Mr. R. A. H. Livett. 7 p.m.

THURSDAY, FEB. 13TH.

INST. OF AUTOMOBILE ENGINEERS.—At Merchant Venturers' Technical College, Bristol. "The Development Testing of Motor Cars," Mr. C. M. Simpson. 7 p.m.

INST. OF ELECTRICAL ENGINEERS.—At Grosvenor House, W.1. Annual dinner.

INST. OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, S.W.1. "The San Francisco Bay Bridge," Prof. J. Husband. 6.30 p.m.

FRIDAY, FEB. 14TH.

CHEMICAL ENGINEERING GROUP.—At the Rooms of the Chemical Soc., Burlington House, Piccadilly, W.1. "Some Aspects of Chemical Works Pumping and Acid Handling," Mr. E. A. Reavell. 8 p.m.

INST. OF ELECTRICAL ENGINEERS.—At Grosvenor House, W.1. Annual ball.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Informal meeting. "The Mechanics of Gliding," Mr. Robert Kronfeld. 7 p.m.

MONDAY, FEB. 17TH.

INST. OF STRUCTURAL ENGINEERS : MIDLAND COUNTIES BRANCH.—James Watt Memorial Inst., Birmingham. "The Influence of Direct Labour on Design and Construction of Small Highway Bridges," Mr. C. O. L. Gibbons. 6.30 p.m.

TUESDAY, FEB. 18TH.

INST. OF AUTOMOBILE ENGINEERS.—At Cavendish Café, Cornmarket, Derby. "Torsional Vibration in Automobile Engine Crankshafts," Dr. W. Ker Wilson. 7.30 p.m.

WEDNESDAY, FEB. 19TH.

INST. OF STRUCTURAL ENGINEERS : SCOTTISH BRANCH.—129, Bath-street, Glasgow. "Economical Cinema Design," Mr. J. Fairweather. 7.15 p.m.

THURSDAY, FEB. 20TH.

INST. OF MARINE ENGINEERS.—85–88, The Minories, E.C.3. Junior Section. Film display. 7 p.m.

* Probably most of the Social Engagements will be cancelled.

A Seven-Day Journal

River Trent Flood Protection.

AT a meeting of the River Trent Catchment Board, held in Nottingham on Wednesday last, January 29th, schemes which will affect the entire course of the Trent and its tributaries were proposed for discussion. Two proposals were laid before the representatives of the Board: the first a comprehensive scheme which involves a capital outlay of £2,236,500, according to the estimates; the second a smaller project estimated to cost £1,500,000. The first scheme includes provision for spreading the expenditure over fifteen years. In the amounts allotted to the Nottinghamshire area the first scheme included £600,000 to be expended on the stretch lying between Nottingham and Gainsborough. Under the second scheme only £123,000 was allotted to this reach and work was limited to the protection of villages with no arrangements for improving the river banks in between. It was resolved at the meeting to ask the Ministry of Agriculture for a grant towards the cost, together with some indication as to the amount which the Ministry would be prepared to find. It was pointed out by the Chairman that in the case of the Yorkshire Ouse Board that authority had accepted a grant of 33⅓ per cent. and that part of the money was being paid during the current financial year. Under the circumstances it was possible that Nottinghamshire might also obtain a grant before the end of the present financial year towards the proposed Trent scheme.

Oil Drilling in Great Britain.

IN a Journal note on November 22nd last the granting of licences to the D'Arcy Exploration Company to prospect in areas totalling 5438 square miles for the purpose of discovering accumulations of petroleum was announced. The first test drilling under these licences is expected to begin early next month at Paulsgrove, Portsdown Hill, near Portsmouth. The company, which, it will be recalled, is a subsidiary wholly owned by the Anglo-Iranian Oil Company, has started the erection of a "combination" drilling rig. A special road to the site has been constructed and experts from the company's drilling staff, many of whom have had experience in Persia, will be in charge of the operations. It is expected that the company will avail itself of its other licences and begin to drill in other parts of Southern England during the course of this year. Other possible sites are Hampshire, Dorset, and Wiltshire, and, in addition, expert geological and geophysical field companies are to make surveys in the North and East Midlands. It is understood that new applications for licences are being considered at present by the Mines Department of the Board of Trade. Between fifty and sixty applications for licences had been received up to the end of 1935. The chairman of the Anglo-American Oil Company, Mr. F. J. Wolfe, has announced that his company would not be found lacking in the active search for crude oil in Great Britain.

The Demolition of Waterloo Bridge.

IN articles published in our issues of December 20th and January 3rd we described and illustrated the progress made in the demolition of Waterloo Bridge, which is being carried out by Sir William Arrol and Co., Ltd. A further stage in the work has now been reached. As the greater part of the stonework forming the arches has been removed, it remains to demolish each pier, and to clear away the foundations. Work has just been begun on the construction of a cofferdam formed of steel piling, inside which the work of demolition is to be carried on. In order that a passage for river traffic may be maintained, two piers will be dealt with at a time, No. 5 and No. 6 in midstream being attacked first. It is hoped to remove them in about three months. Around the cofferdam, which will be 100ft. long by 38ft. wide, a staging will be built to support derrick cranes and the other equipment for loading the material into barges. It is anticipated that the construction of the cofferdam will take a month to complete. The work of demolishing the bridge began in June, 1934, and has proceeded steadily, but another year will elapse before the last pier and its foundations are removed. About 200 men are engaged on the work.

The Air Navigation Bill.

ON Friday, January 31st, the Air Navigation Bill, which was introduced in Parliament in December last by Sir Philip Sassoon, Under-Secretary for Air, was officially published. It repeals the Air Transport (Subsidiary Agreements) Act of 1930, and enlarges or extends the provisions of that Act. Instead of the £1,000,000 limit of annual subsidies under the 1930 Act, the Bill substitutes £1,500,000 and extends the date during which these subsidies may be paid from December 31st, 1940, to December 31st, 1953. It is estimated that the limit of £1,500,000 will cover the cost of the scheme for the extension and improvement of Empire air routes, announced in December, 1934, and will also provide for the inauguration and development of British Transatlantic air services and for feeder services in Europe and Britain. Another clause in the Bill gives the Secretary of State power to entrust certain of his duties with regard to the design, construction, and maintenance of civil aircraft to a Board representing civil aviation. Several clauses are devoted to a scheme of compulsory insurance of aircraft against third party risks, and it is proposed to limit the liability for third party damage caused by aircraft to amounts varying from £5000 to £25,000, according to the weight of the aircraft. Local authorities which have power to acquire land by agreement for aerodrome purposes are, under the Bill, given compulsory powers. Many of the provisions of the new Bill follow closely the recommendations made by Lord Gorell's Committee on the "Control of Private Flying."

Shipyard Wages.

AT a joint meeting of the Executive Committee of the Shipbuilding Employers' Federation and the Committee of the Shipbuilding Trades Unions, which took place at Edinburgh on Friday, January 31st, Mr. Maurice E. Denny, the President of the Federation, announced that he had been authorised by his Central Board to say that it was prepared to increase the wages of shipyard workers. In view of the representations which had been made and the improved prospects in the industry, the Board was prepared, he said, to depart from its original proposal of December 20th, that the Committees should jointly await the issue of the Lloyd's Register returns for the March quarter. The Central Board, he continued, was agreeable to granting a general advance in wages in two instalments to the Union's members at an early date. Mr. W. Sherwood, who spoke on behalf of the trade union committee, said that it would accept the employers' statement. A joint committee will accordingly meet in London on Wednesday, February 12th, with the object of agreeing without delay to a settlement for national recommendation to the employers and the unions.

The Employment Figures.

ACCORDING to a statement issued by the Ministry of Labour on Monday evening, February 3rd, it is estimated that at January 20th, 1936, there were approximately 10,349,000 insured persons, aged 16–64, in employment in Great Britain. This was 250,000 less than at December 16th, 1935, but 282,000 more than at January 28th, 1935. A sharp decline in employment, the statement adds, normally occurs in January in many industries, owing to a temporary slackening of activity after Christmas. The effects of this seasonal decline were greatly accentuated at January 20th last, by the severe weather conditions which had for some days been adversely affecting outdoor employment. In the building and contracting industries, for example, the numbers unemployed at that date showed an increase of 107,000, compared with December 16th, of whom 65,000 were temporarily suspended from work on the definite understanding that they were shortly to resume their former employment. The principal other industries in which there was a decline in employment, between December 16th and January 20th, were the distributive trades, metal goods manufacture, steel melting, rolling, &c., general engineering, and the transport trades. At January 20th, 1936, the numbers of unemployed persons on the registers of employment exchanges in Great Britain were 1,732,503 wholly unemployed, 345,117 temporarily stopped, and 82,102 normally in casual employment, a total of 2,159,722. This was 291,157 more than the number on the registers at December 16th, 1935, but 165,651 less than at January 28th, 1935. The total on January 20th, 1936, comprised 1,699,943 men, 73,340 boys, 318,348 women, and 68,091 girls. The normal increase in the numbers unemployed in January, compared with December, was accentuated by the registration of a large number of juveniles who had reached the school-leaving age at the end of the December term.

National Aerodrome Planning.

AT the conference of the Aerodrome Owners' Association held in London on Friday last, January 31st, the suggestion was made that a survey of Britain should be undertaken to decide on the most suitable sites for commercial aerodromes. The City Engineer of Hull, Major Herbert Hamer, pointed out that the majority of municipal aerodromes were being run at a considerable loss at the present time. He pointed out that the City of Hull, having spent £50,000 on an aerodrome, was about to "scrap" it, as being too small for requirements. Groups of towns, he pointed out, were vying with one another as to which should own the leading aerodrome of the district, whereas actually one communal ground would be more efficient and economical. The cost of an aerodrome was given by Major R. H. S. Mealing, of the Air Ministry, as over £100,000 all told. He put forward the suggestion that it would be preferable if, instead of municipal ownership, the operating companies, together with the aircraft industry, should be made responsible for the provision of suitable aerodromes, with the assistance of the Air Ministry. The facilities provided in London consisted of Croydon, Heston, and Gravesend, with Gatwick, on the Southern Railway Brighton line nearly ready for use. There was need, however, for facilities on the north or north-east of London. Hendon aerodrome would prove suitable if it could be obtained from the R.A.F. The possibilities of a central airport in London were not good, as it would have to be small in size and the earning capacity in consequence would be much reduced, and difficulties were to be found in the danger to surrounding traffic and also in the frequency of fog in Central London.

New Naval Vessels.

THE Admiralty announced on Tuesday, February 4th, that, subject to the settlement of certain points of detail, it has decided to entrust the construction of the following vessels of the 1935 programme to the Clyde and North-East Coast firms mentioned below:—The minelaying submarine, H.M.S. "Cachalot," a vessel of about 1500 tons displacement, will be built at Greenock by Scotts' Shipbuilding and Engineering Company, Ltd.; while at West Hartlepool William Gray and Co., Ltd., a firm new to the Admiralty contractors' list since the war, will construct the surveying ship, H.M.S. "Gleaner," and the sloop minesweeper, H.M.S. "Hazard." From Australia it is officially announced that H.M.A.S. "Yarra," the new sloop built by the Cockatoo Island Dockyard for the Australian Navy, was commissioned at Sydney on January 21st. A second sloop, the "Swan," is also under construction at the dockyard. Both vessels are of the "Grimsby" class, but of slightly larger displacement, and with a different armament.

The Sentinel Waggon Works Reconstruction Scheme.

IN the annual report of the Sentinel Waggon Works for 1934, issued in June last, reference was made to a reconstruction scheme. On Monday, February 3rd, the directors of the company issued particulars of that scheme, which will be considered at a meeting convened for Monday, February 17th. Under the scheme the business will be taken over by a new company, which will raise additional funds by issuing £50,000 of 5 per cent. debentures and by making calls on shareholders totalling £32,500. The bankers have approved the scheme, and have expressed their willingness to assist the new company by providing finance. In addition, it is anticipated that the realisation of assets no longer required in the business will produce at least £57,500. The bank overdraft, amounting to upwards of £102,500, will be met to the extent of £50,000 out of the funds arising from the realisation of the surplus assets, and as to the balance by a cash payment from the new company, while preferential creditors will be paid in full out of the assets of the present company. Unsecured creditors will receive 5s. in the pound in cash, and income notes of the nominal value of 1s. 8d. in the pound, which will be redeemed out of the new company's net profits. The directors state that undertakings have already been obtained to subscribe for the debentures and to underwrite the calls on the new preference and ordinary shares. The scheme is recommended as being the most equitable that can be put forward, and the directors anticipate that the reorganised company will be able to carry on profitably. The first directors of the new company will be Lord Selsdon, Mr. S. E. Alley (who will act as managing director), and Mr. N. W. Duthie.

The Naval Conference.

FOLLOWING the postponement of the meeting arranged for January 21st, the first committee of the Naval Conference met on Wednesday, January 29th. After welcoming the Japanese "observers," the Conference opened discussion on the subject of qualitative limitation. The Chairman, Lord Monsell, recalled the proposals made by the British Government to the Disarmament Conference in 1932, which it would still like to see adopted. In view of the conversations held last year preliminary to the present Conference, there was little hope of securing agreement to such drastic reductions. Accordingly he put forward as a basis for discussion limitations for capital ships of 35,000 tons and 14in. guns, with a possible reduction of 2000 to 3000 tons in this displacement; for aircraft carriers, 22,000 tons and 6·1in. guns; for "A" class cruisers, no more ships to be built during the term of the proposed agreement; for "B" class cruisers, 7500 to 8000 tons, with 6·1in. guns; and for submarines, 2000 tons and 5·1in. guns. These figures were accepted as a basis for discussion by all delegations, and it was decided to refer to a new technical sub-committee the question of definition of all technical matters. The report of the sub-committee considering the question of advance notification and exchange of information regarding naval construction was considered and adopted on January 31st. The second sub-committee is continuing its study of the definitions of various classes of ships and of "standard displacement," on the age limits of each class, and on the qualitative limits to be included in the treaty. It is understood not to have completed the first item on its agenda, and to be still engaged on the drafting of definitions.

American Beach and Shore Protection Works.

By E. E. R. TRATMAN.

No. IV.

(*Continued from page 118, January 31st.*)

New York Beaches.

THE City of New York has within easy reach a number of fine beaches on the south shore of Long Island, and the line of sandy islets which are strung along its ocean front for more than 50 miles. These long and narrow islands are separated from each other by ocean inlets and from the mainland by salt marshes and large irregular bars with usually shallow water. The beaches are exposed to the full fury of Atlantic storms, which cause extensive and periodical erosion of the shore line and encroachment of the sea, while between storms there is generally some accretion tending to restore the shore line and build up the beaches. There is also a littoral movement which carries the sand continually westward, so that the inlets or channels are subject to gradual changes.

Coney Island Beach.

The beach nearest to the City of New York, and the one most popular and most frequented—being easy of access for even the poorer people and their children—is the famous Coney Island. It is one of the city's greatest and most popular pleasure resorts; a species of Margate, with its shows and amusements, in addition to extensive bathing facilities along a splendid sandy beach.

A good part of Coney Island has been eaten away beyond recovery, and some fifty years ago the violent storms tore away so much of the beach at one point that a large summer hotel which had had a bathing beach in front was pulled back several hundred feet to save it from destruction by undermining. Early protective measures were largely ineffective, as individual owners tried various methods, independently of their neighbours and with low cost as a main consideration.

In 1921 a law was passed by the Government of New York State authorising the city to acquire the beaches and to construct protective works and esplanades. These latter were to be viaducts of such height as to permit owners of property in the rear to pass under the structures and have free access to the beach.

The plan adopted for protective works was to build a series of sixteen groins extending out 600ft. from the high-water line and spaced about 600ft. apart. Their tops were about 2ft. above the high-water level. Hydraulic dredges then pumped in nearly two million cubic yards of sand between the groins. For the first 400ft. the groins were built of creosoted timber, with a double row of interlocking wood sheet piling, waling pieces and round piles, these latter driven to an average penetration of 17ft., and the sheeting 15ft. For the 200ft. at the outer end, in 12ft. to 20ft. of water, the groins are of loose rock, in pieces weighing from 100 lb. to 7 or 10 tons. The top width is 5ft., with side slopes of 1 on 1.

Along the landward ends of the groynes extends an elevated promenade 80ft. wide and about 10,000ft. long, with reinforced concrete piles and cross girders supporting a deck or floor of creosoted planking. This deck is about 13ft. above high-water level, and is approached by ramps from the streets leading to the beach. Beyond this promenade viaduct, which follows the outline of the shore, the beach was designed to be made 100ft. wide to the high-water line, by means of new sand placed by the dredges.

These works, extending along some 10,000ft. of the beach, were finished in 1923. After a few months, the sand began to show considerable irregularities, and there was fear that the beach thus artificially made would soon be washed away. However, these disturbances proved to be only the work of the sea in smoothing out the beach to its natural slope. By 1925 the beach had become practically stabilised, and in some parts accretions were forming. In 1925 this protected beach was extended 3300ft. eastward by building five additional groins and pumping in nearly a million cubic yards of sand.

After ten years of service, a large part of the beach is wider than when the sand was placed to form a width of 100ft. above the high-tide line. At a few points the sea has persistently encroached, tearing out the beach whenever new sand is pumped in. The reason for this peculiar action has not yet been determined, but may lie in some sunken wreck or other undiscovered obstruction off shore. Owing to the continual westward drift of the sand, the extreme east end of the beach is becoming denuded, and it will be necessary to pump in additional sand to make good the loss.

To stop persistent erosion of property at the eastern end of Coney Island, owned by a land company, a sea wall of loose rock was built in 1912–1915 for a length of about 2½ miles. It is still in excellent condition, but there is no beach in front of the wall. This wall is about 24ft. high, with a base width of some 40ft. to 50ft., and a top width of 10ft. at 8ft. above high tide. With rough quarry blocks of 5 to 6 tons weight, it was possible to build up face slopes of about 1 vertical on ½ horizontal, and the entire mass is composed of rocks weighing from 1 to 6 tons.

In order to reclaim some of the eroded land this wall was built 300ft. to 800ft. out from the then existing shore line. On its rear side was placed a filling of cinders and ashes having a width of 10ft. at the top and 20ft. at the base. Hydraulic dredges then pumped in sand to fill the enclosed area, the bed of cinders preventing any escape of sand through the rock wall. On top of this wall there is now a concrete esplanade. During heavy storms some sections of the concrete walk are dislodged and the adjacent lawns damaged, but the damage is soon repaired.

Jones Beach.

As the population of New York City increases, the development of the beaches for public use extends further and further eastward along the Long Island shore. Until a few years ago Jones Beach, 30 miles distant, was a sand bar several miles long and ½ mile wide. Year by year the size and shape of the island or bar changed under the influences of waves and weather. Its development as a public park and pleasure resort, begun in 1927, has included beach bath-houses—with accommodation for 15,000 persons—swimming pools, playgrounds, and great areas for the parking of automobiles. Great quantities of sand have been pumped in to widen the Atlantic side of the beach.

To guard against future troubles due to erosion, studies were made of shore line maps, dating as far back as 1834, and of the changing areas of erosion and accretion. All buildings and other facilities have been located clear of unstable areas, and sufficiently far back from the storm-water line. Long flat slopes of about 1 on 30 of the hydraulically placed sand are relied upon to resist the ocean's attacks, the force of the waves being dissipated as they sweep up the long flat slope in shallowing water. As an added precaution, no works have been allowed to interfere with the original high sand dunes behind the beach, these being left intact.

Rockaway Beach and Jetty.

Eastward from Coney Island is the long and broad stretch of the Rockaway Beach, which ends at an ocean channel or inlet forming an entrance to Jamaica Bay. The beach is on a long narrow peninsula or sand spit along the south side of the bay. The continual westward drift of sand has threatened the existence of this channel, and as the land-locked bay is the site of future development as a marine terminal and industrial area, it was necessary to stabilise the channel to ensure the safety of navigation.

The beach, lying approximately north-east and south-west, is exposed to the open Atlantic, and winds and waves from the south-east cause the sand to move steadily westward. Waves from the south and south-east rolling obliquely to the shore accentuate this movement. Thus the west end of Rockaway Beach has advanced more than 4 miles in about 200 years, with an average annual advance of 240ft., and further movement might obstruct or alter the Rockaway Inlet. In addition, flood tides entering through the inlet carry sand which is deposited in the quiet waters of the bay, causing the formation of shoals and bars. Still further, great quantities of the moving sand are swept into New York Bay. It is estimated that about 200,000 cubic yards have been added yearly to the west end of Rockaway Beach, and 1,800,000 cubic yards deposited in New York Bay. Groins have been built by the United States Government, the War Department having control of navigable waterways. But their effects have been only temporary.

To prevent this sand movement from causing further changes in the inlet or channel, a curved jetty about 8500ft. long was built in 1933. At Rockaway Point, the west end of the sand spit, the jetty begins 200ft. above the high tide line, and extends nearly west for 2400ft., then with a curve 1600ft. long, it sweeps round and extends south for 5000ft. Its last 500ft. is an apron, to prevent scour. No jetty is required on the opposite side of the entrance. The water area east of the jetty is expected to be filled by sand accretions in from twenty to fifty years.

This jetty is of loose rock construction, with its top 9ft. above mean low tide. For 4000ft. it has a top width of 10ft. and side slopes of 1 on 1. Beyond that the top width is increased to 10ft. and the slopes are 1 on 1½. The core or body is composed of rocks weighing from 20 lb. to 6 tons, with 20 per cent. of the pieces weighing 20 lb. to 200 lb. For the slopes and cap the stones weigh at least 6 tons, and were required to have the least dimension not less than one-third of the greatest dimension. The largest blocks weighed 20 to 27 tons. In all, nearly 500,000 tons of rock were used, of which the largest pieces approximate 200,000 tons.

Rock for the core was dumped from railway cars on a temporary trestle built along the centre line of the jetty. However, when nearly completed a storm demolished the trestle, and the work was finished by floating derricks handling stone from barges. All the cap stones and the facing stones on the slopes were set in place carefully by the derricks.

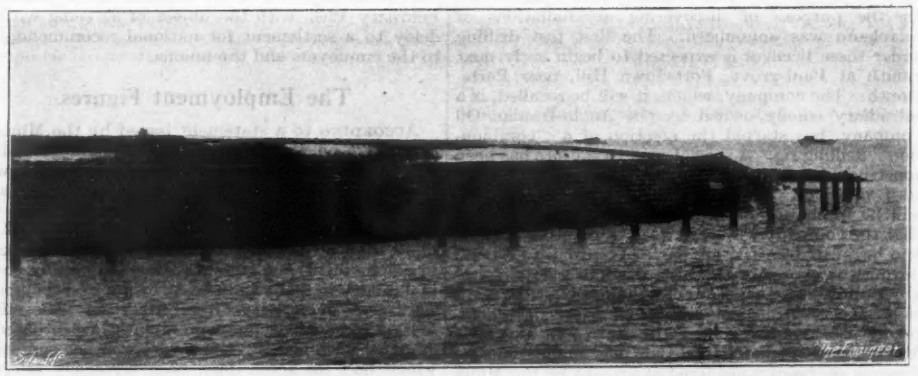


FIG. 28—STEPPED CONCRETE SEA WALL FOR LAND RECLAMATION. NEW ORLEANS

Long Beach, Long Island.

Beyond the east end of Rockaway Beach, and separated from it by a wide ocean inlet, is the small city of Long Beach, which has about 3 miles of ocean beach. Protective works here have been only partly successful.

In 1926 the continual encroachment of the sea upon valuable property along the water front led to a study of the situation, and the preparation of plans for a series of groins about 350ft. apart and 400ft. long, with a bulkhead or shore wall between them at points where the sea had encroached seriously beyond the property line. A great storm in February, 1927, when the work was far from complete, caused enormous damage to the unfinished groins, and to property and buildings along the shore, as well as to a timber promenade or viaduct along the beach.

The damage was greatest at places where no groins had even been commenced. Here the sea washed away the beach to a depth of 5ft. to 8ft., causing the destruction of a number of summer residences and other buildings by undermining the foundations. In this way the shore line was pushed back 100ft. to 150ft. inland. Some of the groins were heaved up and others were overturned or breached. Although they stood at different heights above the sand, their height appeared to have no relation to their stability. However, the breaching and overturning was attributed to floating wreckage and heavy timbers, rather than to direct wave action.

Although these groins were repaired and completed later, it is reported—in 1935—that they have not fulfilled their purpose so far as building up the beach is concerned. Furthermore, they are said to be of insufficient length to check the littoral drift and impound the sand, while they were not strong enough to withstand the heavy ocean storms. In fact, most of the groins are said to be in bad condition at the present time. Nevertheless, the construction seems to have been reasonably substantial, and it was stated after the storm of 1927 that if no groins had existed practically all the buildings along the ocean front would have been destroyed. Where the bulk-

head or end wall was built between the groins it has stood up fairly well, and has served its purpose in protecting the property in its rear.

Most of the groins were entirely of timber, consisting of a double row of tongued and grooved 4in. by 8in. wood sheet piling, with two lines of 6in. by 8in. waling pieces on each side. Outside these were round piles, 6ft. apart, but staggered on opposite sides of the groin. These piles were bolted through the wales and sheeting. Sheet piles were driven to an average penetration of 15ft. to 18ft., and round piles to about 23ft. Similar construction was used for the bulkheads, but with a single line of 3in. by 10in. sheeting and round piles, 6ft. apart on the rear side only. Some of the piles were attached to anchor piles by tie rods; others were backed up by inclined brace piles whose heads were fitted against the heads of the round piles.

SEA WALLS AT NEW ORLEANS.

While New Orleans fronts on the Mississippi River, it has Lake Pontchartrain—a tidal lake, 25 by 40 miles—at its rear. In addition to dike or levee protection against river floods, the city has to provide protection against flooding from the lake during violent storms which drive the water over a low-lying part of the city. An area of some 30 acres along the lake front was reclaimed about twenty years ago by means of a concrete gravity sea wall, 13ft. high, founded on two rows of 55ft. timber piles, spaced 4ft. apart longitudinally, in rows 5ft. apart. On each side was a line of triple lap sheet piling, 6in. thick and 16ft. long. Outside the sheet piles were waling pieces, and the two lines of sheeting were tied together by rods, afterwards embedded in the base of the wall. The water face of the wall had a slope of about 1 on ¾, with a projecting coping 2ft. 4in. wide.

The more extensive lake protection work, built in 1930–32, consists of a stepped concrete sea wall about 5½ miles long, following the irregular outline of the lake shore. The steps have 8in. risers and 16in. treads, giving a slope of 1 on 2.

From the view of a part of the sea wall—Fig. 28—it will be seen that it was largely in low and swampy

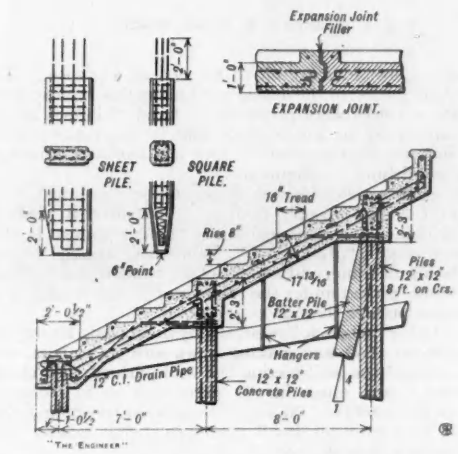


FIG. 29—STEPPED SEA WALL AT NEW ORLEANS

land. In fact, it was built about 2500ft. from the actual shore line, and the area behind it was filled by hydraulic dredges which placed about 32 million cubic yards of material, creating some 200 acres of made land for park and other purposes. A considerable part of this area is being laid out as a high-class residential district in order to make the project practically self-supporting. A concrete roadway, 40ft. wide, parallels the wall, with bridges over two drainage canals and a navigation canal. This sea wall protection and improvement project has been carried out under the direction of the Board of Levee Commissioners.

The design of this sea wall is shown in the drawing, Fig. 29. Preparatory to construction, a line of steel sheet piling was driven as a cofferdam, about 4ft. from the toe of the concrete structure. For the sea wall itself a line of concrete sheet piling was driven at the toe, and behind this, at distances of 7ft. and 15ft., two rows of square concrete piles, 12in. by 12in., ranging from 20ft. to 50ft. in length, and spaced 8ft. apart longitudinally. The sheet piles are 9in. by 24in., with tongue-and-groove edges. In each 40ft. length of wall there are three brace or batter piles to resist the pressure of the back-filling. In soft ground additional brace piles were driven, and the wall was held by tie-rods attached to anchor blocks in the solid ground.

The slab or deck has a minimum thickness of 12in. Its toe is formed as a beam, and at each row of bearing piles the bottom of the slab is formed as a longitudinal rib or beam. At the upper end the slab is cantilevered 3ft. beyond the piles, and is finished with a curb or low wall, 10in. wide, rising about a foot above the slab. The steel reinforcement of the slab is tied to rods projecting from the pile heads, so as to make a solid and homogeneous structure when the concrete is poured and set.

At the ends of each 40ft. section the steps are interrupted by an inclined rib or beam, so formed as to make tongue-and-groove expansion joints between the sections. The joint space is 1in. wide and filled with a prepared material. Where the wall is on a curve the joints are radial and the width of the beams flares out accordingly.

Airport Sea Wall.—In close relation to the lake front protection described above, but independent of it, though also planned and built by the Board of Levee Commissioners, is the sea wall or bulkhead of the New Orleans airport on Lake Pontchartrain, built in 1934. This airport is a triangular peninsula of filled or made land, with sides about 3000ft. long, and having an area of 300 acres. About 7,000,000 cubic yards of material were pumped in by hydraulic dredges, the fill in some places being as much as 20ft. deep. Upon it is a top layer of sand.

With 11ft. of freeboard, a depth of 12ft. to 20ft. of water and a 20ft. bottom or lake bed of soft mud, the problem was to devise an economical type of sea wall to withstand the attacks of storm waves and to sustain the pressure of the fill. The design adopted, and shown in Figs. 30 and 31, consists of two parallel rows of concrete interlocking sheet piles, 15ft. apart. These are connected by 2in. steel rods as ties, passing through rolled steel channels, which form the waling pieces. The metal is all copper content steel, and is thoroughly encased with concrete, the casing of the tie-rods serving to form struts or braces 12in. square.

In both rows the piles are 12in. thick and 24in. long with lengths of 50ft. to 60ft., and having deep

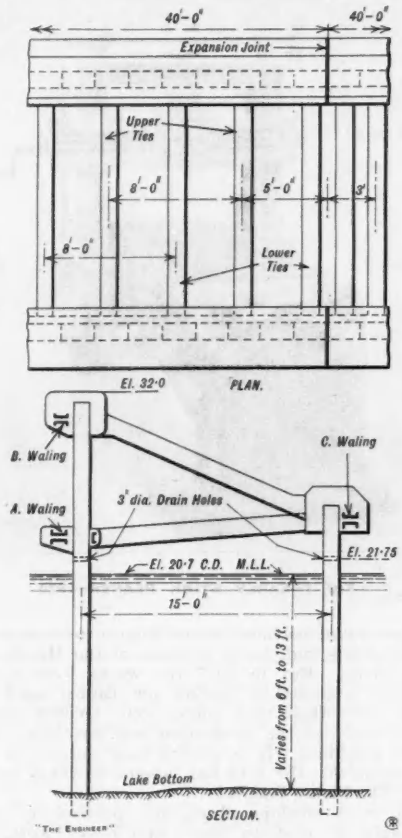


FIG. 30—SEA WALL ON LAKE PONTCHARTRAIN

tongue-and-groove joints. Those of the front row extend 12ft. above the mean water level, while those of the rear row extend only 6ft. above that level. The connecting struts and tie-rods are in two rows, 8ft. apart in each row, but staggered to give a spacing of 4ft. In the lower row they are almost horizontal, while those of the upper row are inclined to connect the heads of the piles.

The tie-rods pass through the piles and between pairs of 12in. steel channels placed with the webs horizontal and back to back. These form the outside wales. In addition, there is a single waling piece of 7in. channel—with web vertical—inside the front row of piles. Each pile is bolted through the wales except where the tie-rods occur, and the channels are also bolted together through the webs. These steel channels are not in contact with the sheeting, as pipe sleeves with washers on the bolts and tie-rods form separators, as shown. Massive beams of reinforced concrete are formed over the tops of the sheet piling, and enclosing the waling pieces. The girders on the outer row of piles, together with that enclosing the lower wales, are so shaped as to act as wave-breaks.

Where the water is less than 6ft. deep only the outer line of sheeting is driven, and these piles are 30ft. to 45ft. long. In this construction, shown by Fig. 32, there is only the one horizontal row of combined ties and struts, 3ft. apart, with inside and outside wales as above described. The top of the sheeting is strengthened by a row of 5in. by 5in. steel angles on each side and bolted through the piles. The shore end of each tie-rod is formed with an eye which is connected by a pin to a steel collar encircling a creosoted anchor pile, 25ft. back from the sheeting. A similar batter pile fitted against an inside waling timber, 12in. square, braces the anchor pile against any tendency to tilt forward. In this construction the wales, but not the tie-rods, are cased in concrete.

The total length of this sea wall is about 11,000ft., of which 6700ft. is of the heavier or double section. Test piles, 12in. square and 50ft. long, sank 20ft. under the deadweight of the steam pile hammer. Below this soft material was a shell stratum, 3ft. to 5ft. thick, and another soft stratum for 6ft. to 8ft., underlaid by a hard stratum of adequate thickness for bearing strength.

As a means of reducing the pressure of the deep wet filling behind the sea wall, the filling between the lines of sheeting consists of oyster shells, which are also piled outside each line of sheeting, on the lake bottom. There are enormous quantities of this

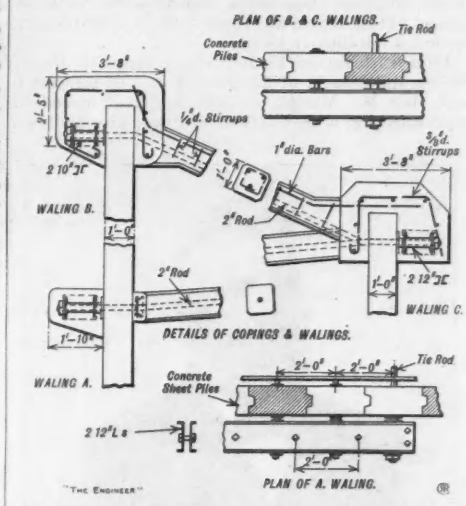


FIG. 31—DETAILS OF LAKE PONTCHARTRAIN WALL

material available within a short distance. Its weight in water is about 1000 lb. per cubic yard, and its angle of repose is about 1 on 2. Owing to the shape of the shells they are not easily displaced. A 2in. drainage hole is provided in each sheet pile.

Mattress protection on the bed of the lake is an unusual feature of this airport sea wall. Along the sides and around the semi-circular apex of the enclosed area is a double course of woven willow mattress, 2ft. thick, and weighted with loose rock. The bottom course is 60ft. wide and the upper course 40ft. Furthermore, for about 2600ft. around the apex, a layer of clay, 200ft. wide, was placed outside the wall by hydraulic dredges. This has a slope of 1 in 50. Upon this clay bed were laid the mattress courses, reducing the depth of water to about 5ft. along the face of the wall. With this shallow water and the

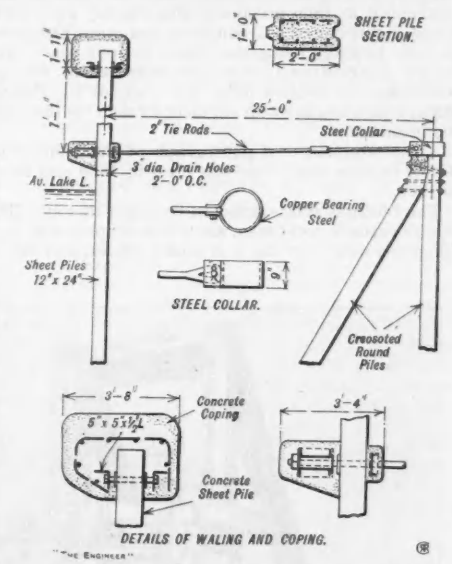


FIG. 32—LAKE PONTCHARTRAIN WALL IN SHALLOW WATER

flat-bottom slope the waves lose their force without breaking, so that comparatively little spray comes over the wall.

A natural inquiry is why the stepped form of concrete sea wall on adjacent made-land was not used for the airport. The reason lay in the construction cost. For the step type of wall a cofferdam, consisting of a small line of steel sheeting was sufficient, with round pile supports and a single waling piece. As this was mainly in about 6ft. of water, the construction was very simple. For the airport, however, projecting into water, 14ft. deep, a cofferdam with double line of sheeting would have been required. The vertical wall with two lines of sheeting cost but little more per linear foot than the stepped wall; but a stepped wall and its double line of cofferdam would have cost considerably more than the vertical wall.

(To be continued.)

British Machine Tool Makers.

By JOHN HOLLOWAY, M.I. Mech. E.

No. II.*

JOHN STIRK AND SONS, LTD., HALIFAX.

THIS firm was founded in 1866 by the late John Stirk, a descendant of that family of Stirks of whom there are records in Craven, Yorks., dating back to the fourteenth century. It is said there have been many John Stirks in the family, but the founder of the business whose work and achievement is the subject of this article was the first from that lineage to become a notable engineer.

John Stirk served his apprenticeship with Messrs. McLea and March, of Leeds, and it is of interest to note that Mr. March, of that firm, had served his apprenticeship with Matthew Murray, who had been

JOHN STIRK, FOUNDER OF THE FIRM

a former apprentice with Henry Maudslay, of machine tool fame. Thus early in his career did John Stirk become associated with the pioneers of the industry, in the development of which he was destined to take a leading part. Following his apprenticeship, he gained a wide and varied experience in some of the leading engineering works of his time, thus acquiring what in those days was considered the essential equipment for a successful engineer.

That his training and experience stood him in good stead is shown by the fact that the business he established in 1866 prospered and steadily grew and is now incorporated as John Stirk and Sons, Ltd., the present directors being the founder's four sons. To ensure the continuation of the more recent family traditions, yet another John Stirk, son of Mr. Rufus Stirk, is in training as an engineer to take his place in the business.

A reproduction of a photograph of the founder is shown on this page. He was born in 1839 and died in 1906.

The business was started in premises of some 700 square yards in total area, and found employment for about ten men. To-day the works, offices, and other premises cover an area of approximately 24,200 square yards and employ in all departments an average of some 500 men, a comparison that affords conclusive evidence of material progress and expansion of the business, and also of increasing usefulness in the employment of skilled men.

Like other machine tool makers of his day, John Stirk began by making a wide range of machines, for specialisation, as it is known to-day, was scarcely on the horizon. The result was that practically any class of tool called for was made to suit the user's requirements, so that during the early years of its existence the firm was engaged in making almost every class of machine tool then known. But, following the death of the founder, and the incorporation of the firm as a limited company in 1906, it was decided to curtail the range of machines and to concentrate on the production of a few well-known types, these including lathes, drilling machines, boring machines, vertical turning and boring mills, and planing machines.

At the outbreak of the war in 1914 these works, like so many others, were declared "controlled," and

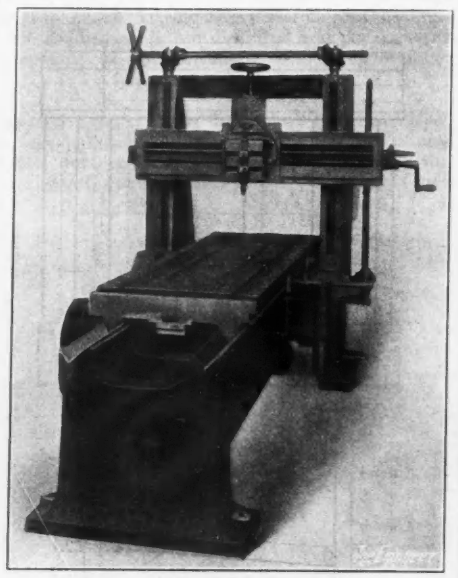


FIG. 1—EARLY STIRK PLANER—1870

the output of machines became subject to Government instructions and, later, to those of the Ministry of Munitions. But in 1917 the works were almost entirely occupied in turning out planing machines, and since then they have been devoted almost exclusively to the production and development of such machines. It is due to their success in this direction that the firm has become so widely known as "The Planer People."

In most machine shops, and particularly those engaged on medium heavy and heavy work, the planing machine may be regarded as indispensable. Hence, right from the time of its invention, the "planer" has always been in demand, and has always claimed the attention of the tool maker. It has constantly been improved and developed and has been kept well abreast of the highest class of metal cutting tools.

Early in the history of machine tool making the need for a tool to produce straight flat surfaces, such, for instance, as are required for the bed of a lathe, became a sheer necessity, and particularly must this have been the case when Richard Roberts made his first cast iron box section lathe bed. Small wonder then that he at once set himself the task of making a machine that would lessen the laborious toil involved in producing straight and flat surfaces by hand. The results of his efforts to this end was the invention in 1817 of the metal planing machine. Fortunately, the machine made by Roberts, and believed to be the first of its type, is preserved in South Kensington Museum, and permission has been given to reproduce a photograph of this historic machine, shown in Fig. 2. It is not necessary here to go into the details of the construction of the machine; an examination of the figure will be sufficient to show how well the essential features are embodied in this original tool. The work table, guided on the ways of the bed, which, traversed by means of the underdrive, slides between the two uprights carrying the cross slide and tool holder, the screws for elevating and lowering the cross slide and

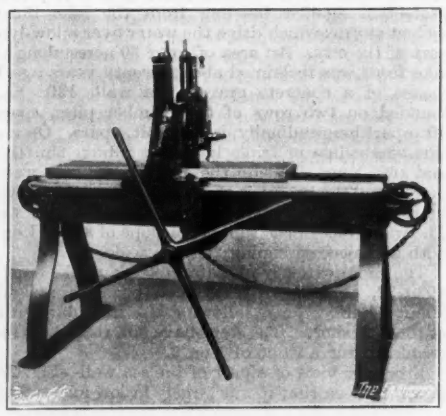


FIG. 2—ROBERTS PLANING MACHINE—1817

the tool holder are all to be seen at a glance. An examination of the actual machine makes it clear that the surfaces were prepared by hand, this fact being considered an added proof that it was made before any machine existed to tool the surfaces, thereby establishing its originality.

Such a machine was bound to be developed, and in 1835 Sir Joseph Whitworth patented a planing machine with a reversible tool holder, known in the works as a "Jim Crow." Whitworth applied power to his machine, and traversed the table with a leading screw, placed under the table, and driven by fast and loose pulleys through bevel gears.

Other makers followed, among them being Nasmyth, who in 1840 was making power-driven planers, the smaller sizes still having the table driven with chain and drum, much in the same way as in Roberts' earlier machine. Nasmyth considered the chain drive to be better for small machines, being quieter and quicker than the gears of the day.

Later came John Stirk in the business of machine-making. Already experienced in the engineering practice of his time, it is not surprising to find that early in his business career, he turned his attention to the further development of the planing machine, and in Fig. 1 there is shown the type of machine he was building in 1870. Its capacity was 2ft. 6in. by 2ft. 6in. by 6ft.

Judged by present-day standards, Stirk's early machine appears a plain straightforward tool, and so it was, and so were most other machine tools of that time. But all the same it was capable of doing

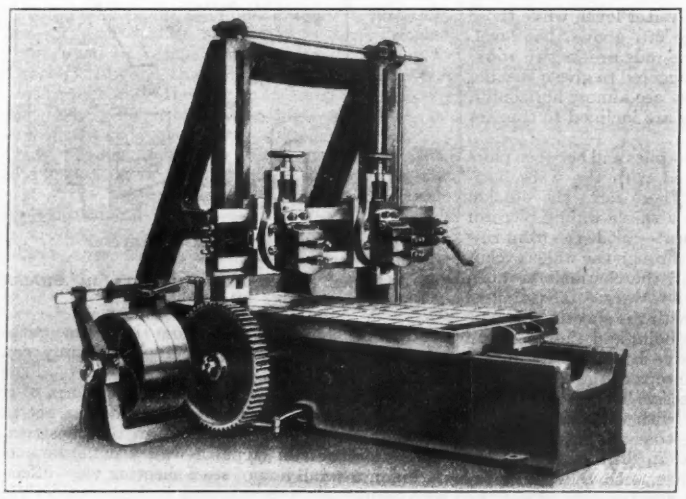


FIG. 3—IMPROVED PLANING MACHINE—1890

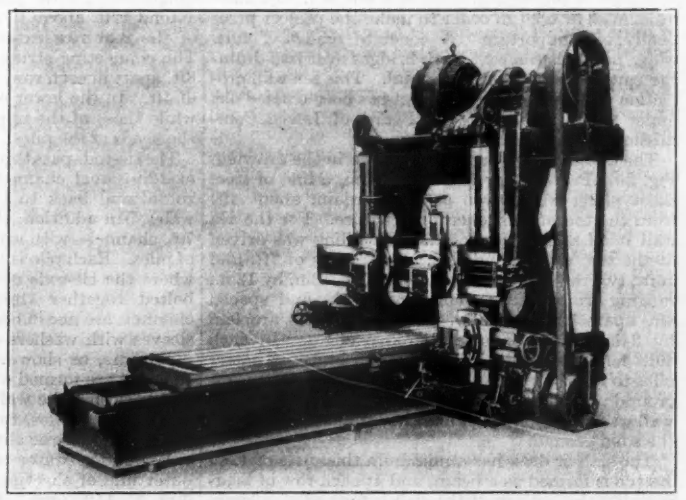


FIG. 4—FIRST STIRK MOTOR-DRIVEN MACHINE—1905

* The first of these articles dealing with John Lang and Sons, Ltd., appeared in our issue of January 3rd, 1936.

THE DEVELOPMENT OF THE STIRK PLANING MACHINE

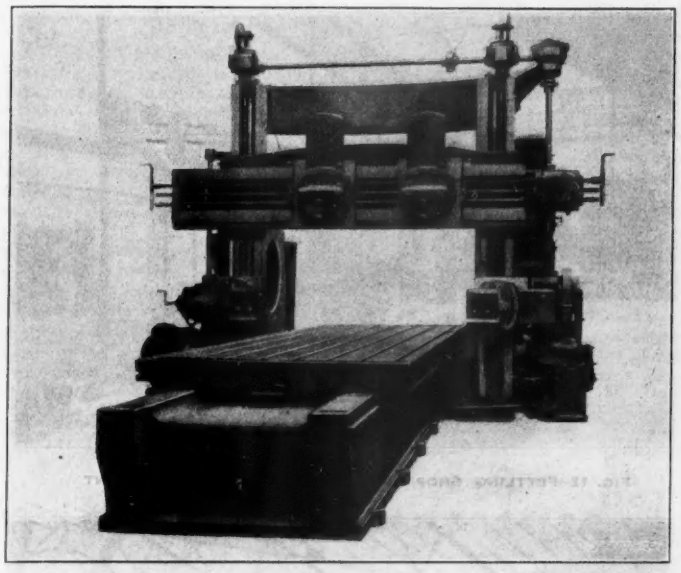


FIG. 5—"HILOPLANE" OF 1915 PERIOD

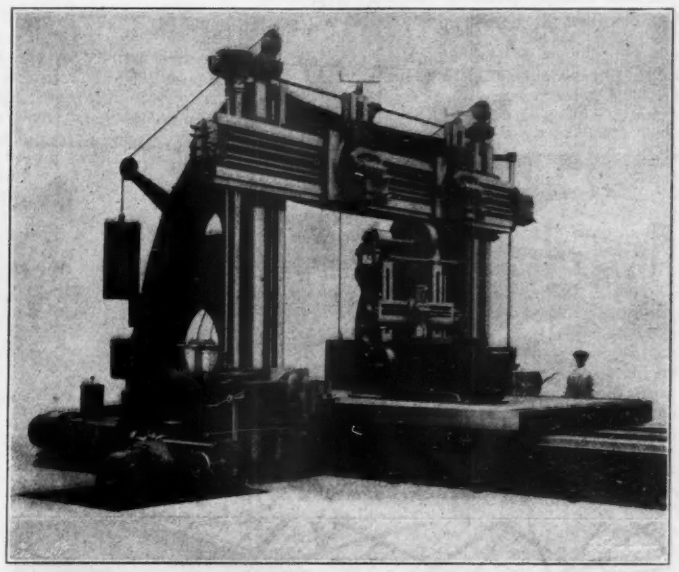


FIG. 6—"VELOPLANE" OF 1920 PERIOD

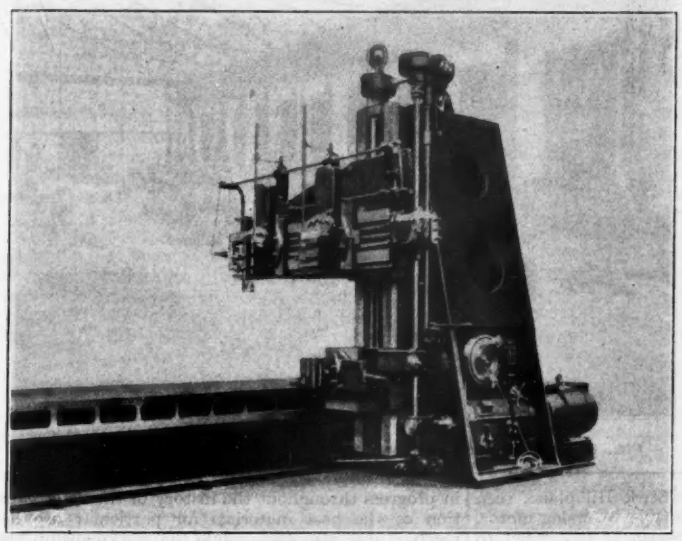


FIG. 7—OPENSIDE "HILOPLANE" BUILT IN 1925

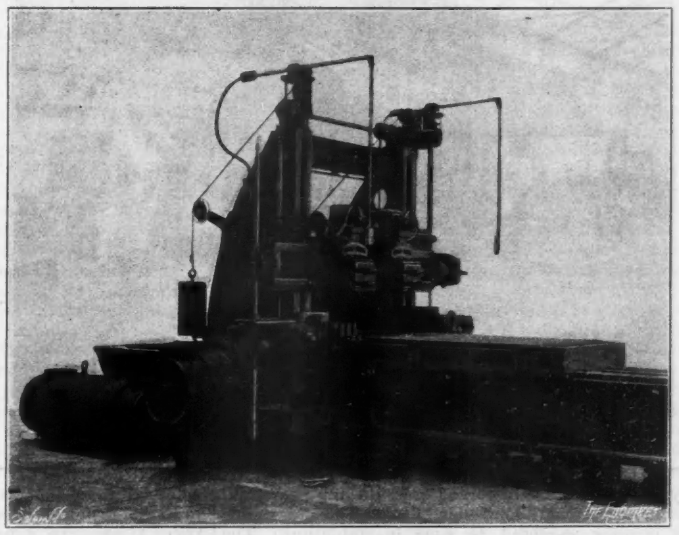


FIG. 8—"HILOPLANE" BUILT IN 1935

good work, while the workmanship put into it, combined with the weight and strength of materials, assured for it a long life. True, the ancient tools were somewhat staid and leisurely in movement, and could not be rushed into doing things too quickly. But they would continue running for years on end at their own pace, and that pace was at least equal to the best cutting tools then available.

To get a true perspective of what progress had been made between the time of Roberts and that of Stirk, it is only necessary to compare the two machines shown in Fig. 1 and Fig. 2. In this comparison there is vividly illustrated a half-century of advancement in design, and the development work of some of the best tool makers of their day.

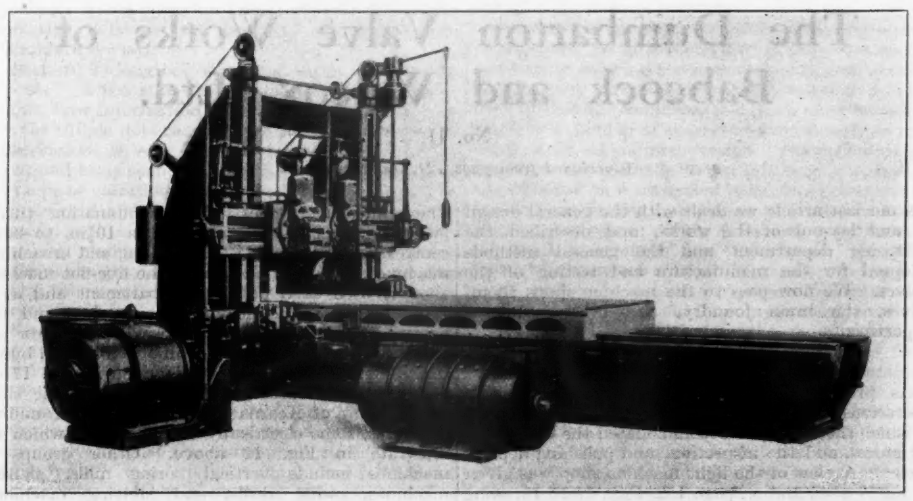


FIG. 9—"HILOPLANE" OF 1930 PERIOD

In the Stirk machine the table was operated by fast and loose pulleys, through a pinion meshing with a rack on the underside. The reversing movement and the self-acting feed to the tool slide were governed by dogs bolted to the side of the table, while the cross slide was raised and lowered by hand, by means of bevels and screws. It should also be noticed that the tool slide could be moved up or down, as well as across the main cross slide, from the control position at the right-hand side of the machine. The whole design formed a strong, compact, and easily handled tool.

Without doubt the early Stirk planing machine met the requirements of that time, and held the field for a number of years. But the engineering industry of the country was fast developing, with the result that larger and more powerful machines were demanded. To meet this demand machine tools generally had to be redesigned and improved. To this, the planer was no exception, and while the principal features of the original machine were retained, that is in so far as its general construction was concerned, the machine was remodelled and improved in many important respects during the next twenty years.

Thus by 1890 the design of the Stirk planer had taken the form shown in Fig. 3. An improvement to be noted is the construction of the bed, which, as will be seen, has been carried from the table ways to the ground throughout the entire length, adding immensely to its rigidity. The table drive has been geared, and the bull wheel can be seen alongside the fast and loose driving pulleys. The cross slide carries two independently operated tool slides, also power connection has been provided for elevating and lowering the cross slide. A wide range of models of the type shown in Fig. 3 was built during the next few years. But soon things began to move more quickly in the whole of the machine tool world. The Paris Exposition of 1900 and the Glasgow Exhibition of 1901 gave great impetus to the improvement in design that had already set in.

It was at this period that manufacturers began demanding more powerful machines for higher cutting speeds and feeds, to use to advantage the new tool steels that were becoming available. To meet this demand, machine tool makers soon began to add motor drives to their machines, and by 1905 Stirk's were making the type shown in Fig. 4, a 5ft. by 5ft. by 12ft. machine. The advent of the motor drive marked an important stage of development throughout the industry, and its addition to the Stirk planer undoubtedly marks an epoch in their history as makers of that specific tool. The illustration is of special interest as showing the firm's first application of the motor drive to planing machines and its practice at the 1905 period. As will be noted, it is a single-motor drive, the motor being mounted overhead, and driving the machine through open and crossed belts. Power for raising and lowering the cross slide is also taken from the motor with the two-belt drive. Other special features are the substitution of friction disc feeds for the old Kicker

THE DUMBARTON VALVE WORKS OF BABCOCK AND WILCOX, LTD.

FIG. 11—KEARNS BORING AND FACING MACHINE

FIG. 12—FETTLING SHOP AND SAND-BLASTING DEPARTMENT

FIG. 13—THE BRASS FOUNDRY: MORGAN OIL-FIRED FURNACES

FIG. 14—THE BRASS FOUNDRY: MOULDING MACHINE SECTION

type, and the use of forged steel driving gears and rack, for strength and reliability. The cross slide is counter weighted to ease manipulation. The machine has four tool boxes, and altogether the appearance is that of a powerful high productive tool.

But the system of overhead drive was not to last long, and new models followed in relatively quick succession. Improved motors, with variable voltage, were applied to planing machines, and in 1910 Stirk planers were being made with direct-coupled motor drive. The higher cutting speeds made possible with this system pointed to the need for improved feed motions, and for quick power traverse to the heads, and in 1912 Stirk machines were made with electro-magnetic feeds and quick power traverses.

Following close on this latter development came the machine known as Stirk's Patent Hiloplane, shown in Fig. 5, built in 1915. The name of the machine, "Hiloplane," was adopted to denote the type of gears used for the main drive. These gears have alternate ratios, giving high and low speeds at will. In all Stirk "Hiloplane" machines, the driving gears are made in forged steel, solid with the shaft. Thus there is an entire absence of keys throughout the system. A notable feature and one every maintenance engineer will appreciate.

During the years 1920 to 1930 other types of Stirk Hiloplanes were evolved, and Fig. 6 illustrates the first Veloplane type built in 1920, the capacity of this machine being 12ft. 6in. by 9ft. by 16ft.

This machine marked the end of Stirk's development of planing machines during the first half-century of their work. And also it marked a century of progress in planing machines since Roberts completed his first hand-made tool. It is a striking example of development. Compare Fig. 1 and Fig. 2 for the first half-century, and Fig. 2 and Fig. 6 for the second half-century, to appreciate what has been accomplished.

But in machine tool making, as in all engineering work, there is no finality, and development continued. In 1925 the first Stirk patent openside Hiloplane made its appearance. This machine is illustrated in Fig. 7. Here is seen the double-plate type of work table, now adopted on all Hiloplane machines, and the magnetic tool lifter. Note, also, the disc and master switch which control the table and cross-planing motions.

Then followed another Stirk patent Hiloplane, in 1930, having a Unit-type motor generator, and tool-relief by single solenoid, shown in Fig. 9, and again later, in 1935, another Stirk Hiloplane, seen in Fig. 8, driven with a flange-type reversing motor. There is also the individual solenoid tool relief to all four heads, and duplicate pendant controls.

All Stirk "Hiloplanes" are driven by direct-coupled motors, operating on a split Field drive. Extraordinary cutting and reverse speeds are attained with this drive. It is recorded that cutting speeds of 500ft. per minute have been reached, but the cutting speed usually recommended is 300ft. per minute, which appears to be more in the region of practicability for every-day shop practice.

While development in design has been constantly in progress throughout the history of the firm, selection of the best materials for particular use has received due attention, while the workmanship and finish of the machines has kept well abreast of modern requirements. One example will be sufficient to show the accuracy attained on these high-class planing machines. For alignment of the machine beds a special Stirk micrometscope is used, this instrument being a combination of micrometer and microscope, by which the smallest error can be detected, and limits of error as low as 0·0001in. per foot have been attained, a figure, which, for accuracy, speaks for itself.

The Dumbarton Valve Works of Babcock and Wilcox, Ltd.

No. II.

(*Concluded from page 121, January 31st.*)

IN our last article we dealt with the general design and lay-out of the works, and described the calorising department and the general methods adopted for the manufacture and testing of the valves. We now pass to the machine shops themselves, the brass foundry, and other auxiliary departments.

THE MACHINE SHOPS.

As previously mentioned, the main machining operations are carried out in a five-storey building in which there are also accommodated the tool-room, jig stores, and the inspection, and polishing departments. A view of the light machine shop was given in Fig. 7 *ante*, and on page 152, Figs. 15 to 18, some typical views of the medium and heavy machine shops and the brass-finishing departments are given. The light machine shop includes, we noted, machine tools of the very latest pattern, including combination turret lathes with air-operated chucks, hexagon and flat turret lathes, vertical and horizontal milling machines, thread millers, high-speed drilling machines, and grinders. In the medium machine shop (Fig. 15, page 152) there are placed the machines for producing the larger iron and steel valve components. They include, besides Ward combination turret lathes, various lathes ranging from 10½in. to 26in. centres, also milling, slotting, drilling and broaching machines. The ground floor of the five-flat machine shop is used as a polishing department and as a general store. The heavy machine shop and the heavy and light valve assembly departments are arranged alongside each other in a well-lighted building, a general view in which is given in Fig. 17 on page 152. A feature of the heavy machine shop is a battery of Kearns boring, facing, and milling machines, some electrically driven, one of which we illustrate in Fig. 11 above. Other groups of machines include vertical boring mills, planing machines, radial drills, and slotting machines, while there are, we noted, specially designed internal grinding machines with double thrust heads for the finishing of the internal seats of parallel slide valves. Alongside the heavy machine shop are the light and heavy assembly departments, parts of which will be seen in Fig. 17. These departments include the hydraulic testing plants and the steam-testing boilers illustrated in our last article. The completed components all pass into the finished component stores, and a complete card-indexing system shows the

quantities of parts on order, delivered, issued for assembly, and in stock, enabling any parts particularly urgently required to be more quickly obtained.

THE BRASS FOUNDRY.

In Figs. 13 and 14 we reproduce two views of the brass foundry, which, in addition to the usual pit type furnaces, is equipped with five oil-fired Morgan furnaces, some of which have been specially designed to melt cupro-nickel alloys. The moulding machines, some of which are shown in Fig. 14, are of the jolt-ram pattern. Working in conjunction with the foundry there is a well-arranged core department with its mould and core-drying ovens. The fettling shop (Fig. 12) contains a Tilghman sand-blasting plant and rumbler, hack saws, and grinders for dressing the finished castings. We noted that there is a well-equipped pattern shop complete with the latest wood-working machinery. Alongside the fettling department is a special section of the works specially devoted to the maintenance of the tungsten carbide tools which are used in the brass machine shop. In this department there are not only storage bins for the various tools, but also a four-spindle special grinding machine for shaping and sharpening the tungsten carbide tools.

THE BRASS MACHINE SHOP.

The brass machine shop (Figs. 16 and 18 on page 152) contains machine tools of the very latest pattern, all operating with individual electric drives, and tungsten carbide cutting tools, and employing spindle speeds up to 2000 r.p.m. They include, as our illustrations indicate, not only Ward and Herbert capstan and combination turret lathes, but also general purpose lathes and machines for the necessary drilling and milling operations, along with such special operations as engraving. The work in the machine shops is planned and rates fixed in works offices which are situated in the north-eastern corner of the valve works. The full instructions given to the machinist for each operation enables the cutting time and the setting times to be performed in the most economical way.

In describing these works we have made no reference to the tube mill shown on the plan, as this does not call for special description.

Literature.

The Application of Statistical Methods to Industrial Standardisation and Quality Control. By E. S. PEARSON, D.Sc. London: The British Standards Institution. 1935. Price 5s. net.

THE British Standards Institution invited manufacturers to a meeting to discuss means of obtaining closer co-operation between those engaged on the theoretical development of statistical methods and those whose functions would be to apply them practically to problems of specification and quality. A committee was accordingly appointed, whose first term of reference was "to report on the application and use of standardisation and specification of quality." It was also agreed to frame a report calculated to awaken interest on the part of manufacturers in the application of statistical methods, and this has been ably performed by Dr. Pearson in the book before us.

It is desirable to distinguish between the use of statistical methods in problems concerning specification, standardisation, and routine production work, and in those involving special research. It is with the former that this publication is concerned.

Section 1 deals with the general scope of the book, and indicates the manner in which statistical technique can be used in the solution of many industrial problems, and may even help in the detecting of some of the causes of trouble in processes, and enable simple routine checks on efficiency to be applied.

Section 2 illustrates the general problems by means of specific examples, those taken being the tensile strength of malleable iron castings, the breaking strength of cloth, and the ash content of samples of coal. In the first case no less than 20,000 test results were taken from seventeen different sources, and then, being carefully tabulated, were plotted as a dot diagram, which clearly indicated those tests that fell outside specification requirements. From the figures it becomes apparent that the mere statement of maximum and minimum strengths do not give an adequate measure of variation, for one abnormal specimen would most unfairly influence the result, and this indicates the necessity for establishing "standard deviations."

Section 3 describes what the author terms the "tools" of the statistician, and the reader is also shown how information may be presented, not only by the simple dot diagram, but when the number of observations is very large by a frequency distribution, and he is soon brought to appreciate the value of range of variation. When there is no great lack of symmetry the mean and standard deviation provide a useful indication of the limits within which variation may readily be determined. When variation is uniform the greater the number of observations, the nearer the frequency distribution will be to a smooth curve.

Section 4 considers the important subject of sampling and the statistical theory relating thereto, the relation of the sample to the batch is investigated, while an examination of the logical inferences that may be drawn reveals the value of this new method. For instance, if it is known from past experience, carefully analysed, that the distribution curve of length of life for a certain type of electric lamp follows the normal law, and has a mean of 1000 hours and a standard deviation of 300 hours, the statistician can boldly affirm that the chance of the mean length of life in a random sample of twenty lamps falling below 800 hours is 0·0014. The method of sampling is important, and the author has some useful observations on this subject.

In Section 5 the statistical theory is developed in connection with specifications, and the basis of securing conformity to specification. Statistical theory is of assistance in providing assurance for the user on the adequacy of the sampling, and also information for the producer that no unexpected variations in his processes are affecting the quality of his product. It is essential to obtain a sample that is truly representative of a consignment, but it is not always easy. A simple case is that of a sheet of steel, where, owing to irregularities of rolling, samples taken from the edge of the plate would be quite different from those near the middle. Regular statistical methods of sampling should reveal this. From the user's standpoint it is highly desirable that he should know that the producer's level of control remains constant, and for this reason if statistical control is resorted to by the producer it is desirable that the user has access to it. There must always be a certain element of chance in cases where consignment sampling is specified, but the man who has studied and measured this variability is in a very much happier state in determining at what level control should be established. The cost of haphazard sampling to give adequate assurance may prove very expensive, whereas sampling on a statistical method should effect substantial economies.

Section 6 reveals the statistical relationship between sample and batch, and at the outset discusses the variation of mean and standard deviation in samples. This is illustrated again by the case of electric lamps, in which if a whole batch of several thousands were tested, it would be possible to determine the mean efficiency and the standard deviation of efficiency. In practice, of course, this would be quite impracticable, and tests could only be made on several samples, each containing, say, ten lamps. The values now would be found to vary individually from those calculated for the whole batch. The extent of these differences is of importance in assessing reasonable limits for specified requirements. Simple mathematical formulæ are deduced, and in a table the results obtained from them are compared with those from a much more elaborate system of observations, and the agreement, if not perfect, is good enough for practical purposes.

Section 7 is one that will prove of special interest to engineers, for in it is explored the use of statistical methods in securing conformity with specification by consignment sampling, especially bearing in mind the fact that the conditions laid down must frequently relate to a number of characteristics, sometimes independent, at others inter-related. The author clearly describes his methods of establishing a system of classification on a statistical basis, and illustrates the case by considering four makes of sand lime bricks, and he proceeds to divide them into two grades on the basis of strength and uniformity. He grades them by means of standard deviation and also by mean and coefficient of variation. We fully agree that it is important that "a preliminary investigation should be made before the requirements for sampling and testing in a specification are fixed. Besides the purely statistical points, other practical and economic considerations would, of course, need careful discussion." It is not claimed that statistical methods yield everything, but they certainly set forth the facts in such a manner that the characteristics can be observed, and full advantage taken of them.

In Section 8 the reader is taken a stage further, for it is demonstrated that by means of control charts statistical analysis may prove a very useful tool in locating sources of trouble. The essence of the method lies in gathering together, and arranging suitably, test records, so that lack of uniformity may at once be detected. It will then be possible to decide whether the cause of variation may be termed "assignable" or "chance." If the former, the first indication has been given that a thorough investigation is warranted. In all this work the normal method of approach of any scientific inquiry has been taken, that of making a hypothesis and then carrying out tests to determine whether or not observed facts conform to it.

In a large number of these control charts the standard deviation of the batch is really the basis, and if a diagram be drawn showing the standard deviation above and below the mean, the belt across the diagram between these two lines will indicate the area of control. The narrower the belt the more exacting would be the specification. The determination of the standard deviation must naturally depend largely on past experience. It should be mentioned that these charts are valuable, not only in checking conformity to standard, but also in the hands of a careful investigator can be made to reveal much that is suggestive from a study of the dot pattern.

Two figures are shown, each in connection with an examination into the ash content in coal, in one case the mean being 7·49 and standard deviation 2·25, while in the second case they are 8·39 and 4·62 respectively. From an inspection of the control charts it is at once apparent that the ash content in the second case was the greater, and by further analysis the fact is revealed that characteristic features of lack of control are evident in the second case, but not in the first.

In a similar manner, the quality of electric lamps is considered, and in this case not only is the average life at a definite efficiency important, but also the variability in life above the average value. Another example shows how a chart may be used in connection with the improvement of a technical process involved in the production of a manufactured chemical, and also suggests the form of statistical check on the maintenance of the level of control.

When the chart shows that variations are due to assignable causes, these are carefully investigated by the technical staff, who alter the processes with a view to improvement. At a later stage a second control chart would be prepared, and if the expert action previously taken had been a sound one, the results would be clearly shown on the new chart.

After carefully reading this section it is clear that a wide field of exploration lies open to the enterprising process manager.

Section 9 is concerned with performance tests, and indices of quality. There are cases in which no qualitative or quantitative measures of comparison exist, but where the user is anxious to assure himself that the material he is buying is what he calls "the same" as his last consignment, and it is this "sameness" that the statistician will have to resolve into some form that will meet both user and producer. This is a more difficult problem than those hitherto handled, and the author only touches it lightly.

This interesting work concludes with about 50 pages of useful appendices, including among other things a comprehensive list of other publications on the subject, as well as a number of diagrams which are invaluable in eludicating the text.

In reorganising an engineering industry, usually one of the first steps is to introduce an efficient system of cost accounting, and if this is one that aims at a high degree of accuracy, such as the machine hour rate method, a mass of statistical information is essential. Our experience is that the appropriate records have never been kept, and accordingly the system has had to be initiated on a series of assumptions, modified later in the light of experience, as more reliable particulars are gradually acquired, so that it may be some years before the cost accounts give a true record of performance. An analogous state of affairs must exist in the case of statistical control, and it is felt that a definite step forward has been made by seeking to interest manufacturers in the subject, and it is to be hoped that there will be an increasing pooling of resources, so that the number of tests and observations may be a maximum, and the conclusions drawn accordingly of the greatest value.

The Work of the Sanitary Engineer. By ARTHUR J. MARTIN, M. Inst. C.E., M. Inst. W.E., M. Cons. E., F.G.S., F.R. San. I. London: Macdonald and Evans. 1935. Price 16s.

ALTHOUGH there is an active organisation, of which the author of this book has been President, entitled the Institution of Sanitary Engineers, it must not be supposed, by the administrators and officials for whom the volume provides a useful survey of the subject, that sanitary engineering is a defined branch of the profession.

The term "sanitary engineer" applies rather to a synthetic conception, on the one hand, or to specialists in branches otherwise designated on the other, than to a defined branch of engineering. The surveyors of smaller towns are, however, occupied to a very large extent in sanitary engineering duties, while their colleagues in rural districts have, most of them, been relieved or deprived of their highway duties at a time when attention is seriously being given in those areas to the collection and sometimes the sanitary disposal of refuse and to sewage disposal by scientific methods. Throughout this wide field of activity in the pursuit of health through the application of the art and science of engineering, contact is made, though insufficiently, with the medical profession, whilst practice and procedure are mainly governed by Acts of Parliament and by-laws, and are guided by the Ministry of

Health. Evidently, then, a book on the work of the sanitary engineer can fulfil a useful purpose by presenting the subject in regard, first, to main issues, administration, professional training, and economics; secondly, to the application of sanitary science to the various branches of engineering works and services; and thirdly, to the theory and practice of engineering those branches.

Described in the sub-title as "a handbook for engineers, students, and others concerned with public health," Mr. Martin's work fulfils the first of these desiderata. It is, however, disappointing in regard to the second, and, still more, to the third. A prevailing blemish is the extent to which space is devoted to illustrative cases of little importance or of slight general significance, and to mere anecdotes, the author falling back upon volumetric expression, or upon expression by means of a few examples, in default of expertness in the literary counterpart of finding the greatest common denominator or the least common measure. In compensation, or more than that, his style is so simple and direct that he is able to convey his meaning in much less space than would be used by most engineers who write books, while his English is so good and his sentences so well judged as to length that reading the book is like rowing with the stream. Another merit of the volume is that, in respect of physical conditions, described to indicate the nature of a problem or to illustrate some kind of difficulty which may be encountered, the author's interpretations are usually both assured and just; sometimes, unexpectedly illuminating. On the other hand, a serious defect in the book is that it is written too much from the point of view of complacent officialdom. Except in regard to sewage, the author takes little interest in the higher criticism of sanitary engineering or in strivings after perfection. He describes what the authorities are doing, but does not enter into their discussions or concern himself to any considerable extent, either with moot points or with the major planning, constructions, and dispositions which recurrently present problems in engineering services and works. Only to a very small extent does he usefully compare competing methods or discuss trends of practice.

In the first five chapters, Part I, relating to Sanitary Administration, the author explains the character and scope of the Public Health Acts and Local Government Acts, and matters pertinent thereto. It is to be regretted that he has not taken the exceptionally good opportunity occasioned by the publication of this book to draw attention to the inadequacy in some respects, and the total lack in others, of collaboration between the medical and the engineering professions in regard to public health works and services. Statistical information which medical officers of health and general practitioners could easily provide would prove of great value in their bearing upon those services.

In Part II, Water Supply, the chapter on the chemistry and bacteriology of water is unexpectedly short, having regard to the bearing of that part of the subject upon hygiene. Hydraulics and hydrostatics are presented mainly in respect of primary data, their derivation and tabulation, and the working data based upon them. The author deals in an interesting manner with sources of water and hydrogeology, but the short chapter on the quality of natural water is restricted in scope and is unsatisfactory in that sources upon which villagers have to depend in dry seasons are too readily condemned, despite the fact that there are important precautions in their use which ought widely to be made known. Purification is adequately presented; water softening inadequately. From the civil engineer's point of view, the lack of discussion of types of dams or of their features and construction is in unpleasing contrast with the useful review of pumps. The chapter on distribution of water is mainly descriptive of pipes, hydrants, and air valves, and it includes no consideration whatsoever of problems of lay-out, of entire distribution systems, or of any but one of the main features of such systems.

In Part III, Drainage and Sewerage, the relation of administrative procedure to health is made clear in respect of house drains and sewers, and many important details are well explained. The whole subject of sewerage is very well presented, with useful discussion of main issues and descriptions of constructions and equipment. Sewage Disposal, Part IV, is dealt with in the same thorough manner. In regard to disposal by dilution, the attitude of the author towards ordinary practice in respect of sea outfalls may be regarded as too lenient, a failing made evident also in other parts of the volume.

Having devoted 193 pages to drainage, sewerage, and sewage disposal, the author allots to Refuse Collection and Disposal, Part V, only 30 pages. The simpler data of the subject are fairly well presented, but their significance is not adequately discussed. It will be a shock to cleansing superintendents to find only two uninteresting pages devoted to collecting vehicles. Under the heading "Horses *v.* Motors," the author falls into a trap, being under the false impression that a "comparative test" was one comparing those two means of transport, whereas the horses drew old-fashioned and unsuitable vehicles, while the motors were mounted on vehicles of recent design and far superior in respect of both loading and hauling. Not more fortunate is his choice of an anecdote concerning refuse disposal and recounting how the lady chairman of the "Clean City Committee" of New York was, as she expressed it, "astounded at the orderly way in which the refuse was collected in covered trucks, conveyed to the docks and there transferred to barges." It was this practice, of that or another Metropolitan borough, which, when it was applauded as an example of efficiency in refuse disposal, evoked the caustic comment that it was like putting on clean gloves to throw garbage out of the window. Mr. Martin did not perhaps follow the barge or listen to the language of the bargees. Reviewing the principal methods of disposal, the author for the most part avoids discussion of technical or sanitary aspects, as distinct from features of the methods, but under the heading "Controlled Tipping *v.* Burning," he refers to an "obstinately" held opinion that the only proper way to dispose of refuse is by burning. That opinion is entitled to respect, but the defence of controlled tipping which he quotes from an annual report of the Ministry of Transport is known in well-informed circles to relate mainly to a more widely held view that burning is better than any other means of disposal, and that, with or without prior removal of some of the material, such as dust, incineration should be more widely practised, while controlled tipping should be less readily adopted and mainly confined to cases in which it fulfils another purpose as well as that of disposal. Mr. Martin does not refer to the evidence of responsible engineers, to the effect that the method is in a considerable number of cases practised with that disregard for proper precautions to which it so readily lends itself; nor does he mention the growing tendency to resort to separation at the tip and the installing thereat of a small destructor; nor to the increasing distances to which the refuse must in the future be hauled. At the end of his description of the separation process is the sentence: "The separation of refuse is not a pleasant process, but the preliminary removal of the fine dust robs it of its most objectionable features." No observation is made in regard to the view, strongly held in some quarters, that the method is, in spite of the mechanical aids which have somewhat improved it, one to be condemned, if only because it involves a degrading occupation for the pickers and sorters.

In Part VI, Flood Prevention, Land Drainage, and Coast Protection, 24 pages, the scope of the Land Drainage Acts is explained and causes of flooding briefly described, but the activities of drainage boards and the Thames Conservancy are not included. In regard to measures for combating yellow fever, the success of the Rockefeller Foundation at Guayaquil in stamping out the disease receives the encomium which it deserves, but the author might have added that since about the same date the work of the sanitary departments in a number of South American cities has included the inspection of domestic cisterns, which are covered by gauze, and periodical attention to street gullies. The only practical measure referred to as a means of preventing malaria in Great Britain is the drainage of low-lying marshy areas, no reference being made to domestic water butts, street gullies or pools and channels on sewage farms.

Of the space allotted to the five branches of engineering, all but 51 pages of the book, exactly half is occupied by the two parts relating to drainage, sewerage and sewage disposal. This will be regarded as disproportionate by water supply engineers and cleansing superintendents; but it is not to be overlooked that the volume deals comprehensively with law and administration in respect of the subject as a whole, and in sufficient detail in relation to the branches of engineering included; that it furnishes a large amount of data; presents, at a length amounting to that of a not very small text-book, the subject of drainage, sewerage, and sewage disposal; and that it provides some interesting information concerning and describes important constructions under the other heads.

The work is throughout well documented, and the printing, illustrations, and indexing are very good. In spite of the defects which we have indicated, we believe that Mr. Martin's book will be read with interest by many engineers, will in respect of administrative aspects and sewage prove of value as a text-book, and will be very useful as a work of reference for administrators concerned with the work of the sanitary engineer.

BOOKS RECEIVED.

U.S.S.R. Handbook. London: Victor Gollancz, Ltd., 14, Henrietta-street, W.C.2. Price 15s. net.

The Motor Ship Reference Book, 1936. London: Temple Press, Ltd., 5–15, Rosebery-avenue, E.C.1. Price 5s. net.

U.S.S.R. Economics. By M. Polanyi. Manchester: Manchester University Press, 8–10, Wright-street. Price 1s. net.

Stresses in Statically Indeterminate Structures. Second edition. By H. Yu. Wuchang, China: National Wuhan University Press.

Electrical Engineering Economics. By D. J. Bolton, M.Sc. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 21s. net.

Organisation and Administration of a Municipal Engineer and Surveyor's Department. Second edition. By E. J. Elford, M. Inst. C.E. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 10s. 6d. net.

The Electric Control of Machine Tools.*

By K. W. D. ROBERTS, A.M.S.T.

Motor Types and Characteristics.

There are two main electricity supplies to consider, viz., direct current and alternating current. The former was the more common supply distribution at one time, but the latter is now daily increasing, bringing with it standardisation throughout the country. For some classes of work, direct current, however, will probably be retained even if it entails the installation of converters.

In the main, the characteristics of the various types of D.C. motors are fairly well known—the shunt motor, with its constant speed-load curve, the series motor, with its speed dependent on load, and the compound motor, which is a combination of both. The shunt-wound motor is extremely useful for dealing with variable-speed problems, but is limited to a speed ratio, maximum to minimum, of 4 to 1. The horse-power output is approximately constant throughout this range, whereas, of course, the torque is reduced *pro rata*.

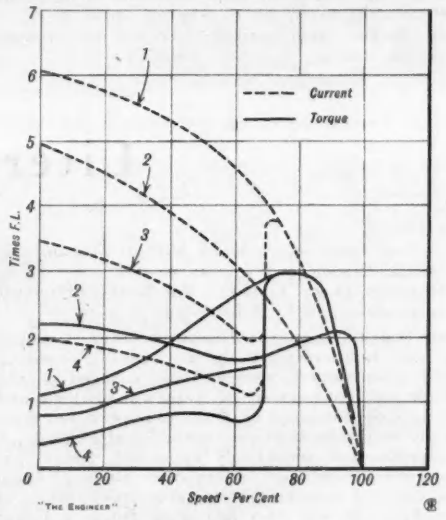


Fig. 1—*Starting Characteristics of Squirrel-cage Motors.*
1. Direct start, standard type of rotor.
2. Direct start, high torque type of rotor.
3. Auto-transformer starting.
4. Star-delta starting.

The series motor is not easy to control in that its speed under light load condition is high, and falls rapidly as an opposing torque is applied. It is used infrequently for machine tool work, and then only in small outputs, such as quick traversing drives, feeds, &c.

The compound-wound motor is used for applications demanding a high starting torque, but with a fairly constant speed.

With regard to the A.C. motor, there are three general types—squirrel-cage or short-circuited rotor, the slip-ring, and the A.C. commutator motor. The general characteristics of each of these is fairly well known.

The squirrel-cage motor is perhaps the most generally used of all types of motors, whether A.C. or D.C., this remark applying particularly to machine tools. It is simple in construction, easy to control, and its first cost is less per output than any other motor. It has a constant speed load characteristic, but it is not capable of any speed variat on.

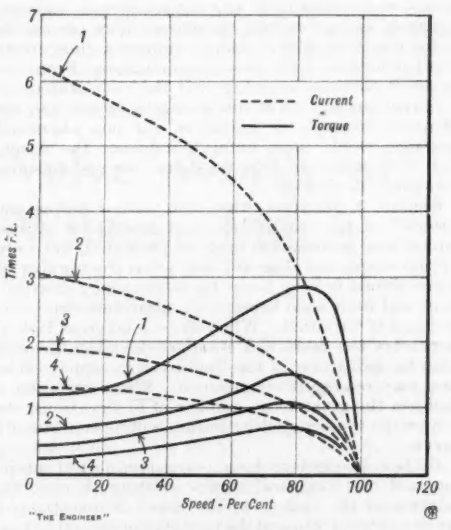


Fig. 2—*Auto-Transformer Starting.*
1. 100 per cent. tapping.
2. 75 per cent. tapping.
3. 60 per cent. tapping.
4. 50 per cent. tapping.

By providing a special rotor it is possible to vary the starting characteristics and the percentage slip at full load.

* Manchester Association of Engineers, Friday, January 24th, 1936. Abridged.

Large machines are generally started by applying a reduced voltage, possible in several ways, to the windings. This reduces the starting current to a reasonable value compared to the full load current. On referring to Fig. 1, it will be seen that whereas the starting or short-circuiting current is possibly six times the full load value for a standard induction motor, that for a high torque type is considerably less with a higher starting torque. The percentage slip at full load is greater in the latter type. The curves are slightly exaggerated for the sake of clarity. Curves 3 and 4 in the same figure are typical curves for reduced voltage condition. No. 4 is that for the common star-delta starting, which in effect applies 58 per cent. voltage to the windings; whilst No. 3 can usually be altered by using different tappings on an auto-transformer. The curve shown is for a 75 per cent. tapping. To show the usual values obtainable by such a method, reference can be made to Fig. 2.

For comparatively small outputs, variation in speed can be attained by the use of change pole squirrel-cage motors. These are, in effect, two, three, or four stators interwound and reconnected to give various numbers of poles. The most common is to wind the stator for 2, 4, 6, and 12, or 4, 6, 8, and 12. The output in horse-power is a maximum at the maximum speed, and ignoring the effect of ventilation and various losses, a constant torque output only is available at the motor shaft.

Should the starting torque required be greater than that obtainable from the squirrel-cage motor, or, alternatively, the starting current be lower, then use should be made of the slip-ring motor. This is started by means of resistances in the rotor circuit, and it will be observed from Fig. 3

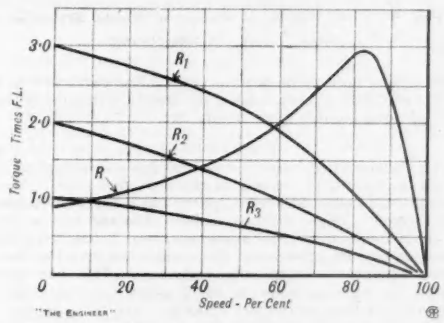


FIG. 3—*Slip-Ring Motor Characteristic Curves.*

that there is a critical value of this resistance to give the maximum torque at standstill. For a heavy fly-wheel starting load, requiring a normal output which is rather larger than many supplies allow for direct starting, the use of a slip-ring motor is strongly advocated. It is possible to design the motor and control, such that, under a certain torque load, a definite speed is obtainable, but should the load be reduced the speed will increase. This is similar to the series motor characteristic except that the speed is limited under no-load conditions.

For variable-speed A.C. applications, the commutator motor presents a proposition worth consideration. Any desired speed between maximum and minimum can be obtained by an intermediate position on the total angular travel of the brush gear. Constant torque is available, and thus the horse-power is proportional to the speed.

The Choice of Rating and Enclosure.—A machine tool manufacturer is often in doubt as to the time rating of the motor he proposes to adopt. Actually for ordinary drives, the saving in cost by reducing a continuously rated motor to a short-time one would only be in the nature of 5 per cent., and therefore hardly worth considering, as the margin of power in hand, as represented by the overload capacity, is certainly reduced.

The question then arises as to the enclosure of the motors driving the tools. Unfortunately, this point is often ignored altogether. There are many cases where the screen-protected type is entirely satisfactory, but should the motor be situated where dirt, metallic dust, or oil and water vapour are carried over it, then the use of totally enclosed or totally enclosed fan-cooled types should be seriously considered. The machine tool manufacturer, too often, is anxious to see the machine through its maintenance period only, and cares very little as to his customers' ultimate troubles. The result is that very often the electrical portion breaks down and the electrical manufacturer is blamed without reason, for in the majority of cases he will not know the particular application of his goods.

Metallic dust is a very serious menace to the life of the insulation. It might be expected that by impregnating the insulating tape and making the windings impervious to ordinary dust and moisture, sufficient precautions had been taken, but from observations made it would appear that metallic dust acts like a number of small drills which bore their way through the fibrous material until the copper is reached.

The safest way of preventing this is to use a totally enclosed machine. The introduction of the externally ventilated type, with its own internal circulating cooling system, has reduced the cost of providing efficient protection, as will be seen in Fig. 4. Only in a few applications will the draught of air, causing a widespread distribution of dust, be considered too serious a drawback to the use of this type.

The Mounting of the Motors.—A comparatively few years ago it was difficult to obtain at a reasonable price any design from the electrical manufacturer other than the straightforward base-mounted motor. Nowadays, however, most of them will provide at a relatively small extra, a flange or end shield mounted type, arranged for vertical or horizontal axis. If necessary, the motor can be fitted with a bearing to take a certain amount of external thrust.

A type of mounting which is perhaps more common on the Continent than in this country is the stator and rotor units which are supplied separately by the electrical manufacturer, and they are then fitted into either a special yoke and frame, or into the machine structure itself by the customer.

From the machine tool maker's point of view, it has been evident that a considerable amount of standardisation of the principal dimensions of motors could easily be effected. The electrical designers are apparently afraid on three counts that such a course is inadvisable, viz.:—

(1) Limitation in design.
(2) Owing to the inconvenience of altering facings, it is hoped that the machine tool manufacturer will standardise on one maker's designs.
(3) Any standardisation would mean the rapid obsolescence of existing designs.

Such arguments have been heard in other lines of business, but where reasonable standardisation has taken place it has rapidly been followed by improvement in that trade. It is not suggested that the ideal position

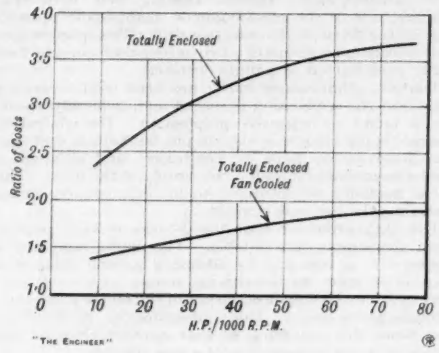


FIG. 4—*Comparison of Costs of Various Motor Enclosures.*
Screen protected type = 1·0.

could be attained rapidly, but steps could be taken now which would certainly improve conditions in the future. Such standardisation is very necessary, not only for the common base-mounted machines, but for flange-mounted machines.

CONTROL GEAR.

Definition—What is control gear and its function in regard to electric power units driving machine tools? It is submitted that it is for the purpose of starting, running, protecting, and stopping electrical machines. The "protective function" covers failure of supply, overload, and internal faults on the electrical circuit, and, in addition, protection of the operator.

Referring back to the motor section, it is found that there are two main supplies to consider, viz., A.C. and D.C., and for each we have the various designs of motors to control.

There are two classes of control gear which can be quite sharply defined:—

(1) Hand operated.
(2) Push button operated.

Let us deal first of all with the hand-operated control gear.

Hand-operated Control Gear.—The simplest form of hand starter is the direct-on-line type, which consists of a three-pole switch. Referring to our definition of control gear, it will be seen that it is capable of starting, running, and disconnecting the motor from the line, but has no protective power whatever. Should a short circuit occur in the motor windings or the connecting table, the switch would not prevent additional damage. The next step then is to add some protection, and this can be carried out by inserting fuses in each line. So far, so good. A fuse protects the lighting system in a house and presumably therefore it should be suitable for protecting the motors. The characteristic of a fuse is shown in Fig. 5.

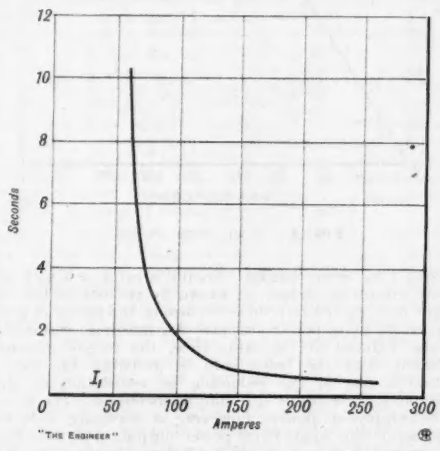


FIG. 5—*Time-Current Characteristic of a Fuse.*

From this it will be seen that to prevent a fuse from "blowing," it is necessary to choose a value, say, I_1, which may correspond to the full load current value on the motor. Now, according to B.S.I. Specification No. 168, a motor of 10 h.p. output, as above, should be capable of withstanding an overload in torque of 25 per cent. for two hours and 100 per cent. momentarily. Assuming that this is approximately the same thing as 25 per cent. overload in current, it will be seen that I_1 must equal the 25 per cent. overload, otherwise it will melt in a comparatively short time. (No doubt, such a fuse would be replaced by the person concerned with one that gives less "trouble.") The fuse therefore will have to withstand 25 per cent. overload continuously, which is quite sufficient to cause serious overheating on the motor windings. The only overload which it will clear is the 100 per cent. or greater, and even then only if the correct section of fuse is inserted. The fact that a squirrel-cage motor, for instance, takes anything in the nature of six times the full-load current when starting is sufficient to indicate that this type of starter has nothing to recommend it except its price. Supply authorities do not encourage the use of the switch fuse, especially in connection with motors of any size, so that its field is strictly limited to small power outputs.

The fuse also gives no protection against the event of supply failure. In other words, any machine standing in consequence of a supply failure is liable to start unexpectedly, with possible serious consequence to the operator.

We have therefore two factors to introduce:—

(*a*) Overload protection.
(*b*) No-volt protection.

In connection with the first function, *i.e.*, overload protection, it may be of interest to touch upon the historical side. Overload relays were introduced in the early days of electrical distribution, which was solely used, as is well known, for lighting purposes. The relay was employed to cut out feeder circuits when some unknown fault occurred (not necessarily an overload). Practice then demanded the introduction of time lags to discriminate between a temporary overload and a continuous short circuit. In consequence, a practice was instituted of employing a time delay of 15 seconds before the main circuit breaker tripped. This figure of 15 seconds has become standardised by use, although for other reasons it is considered too short for use on motor control gear. This has led to the introduction of a double time lag, the idea being that when starting a larger current is allowable for a longer time than when running at full speed. This is effected by means of an oil dashpot, which has a small valve incorporated, such that when a very heavy pull is registered the valve closes against the pressure of a spring and reduces leakage through the piston. A typical characteristic curve is shown in Fig. 6. Curve

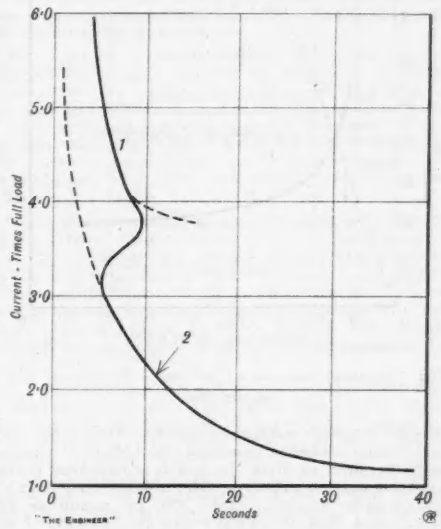


FIG. 6—*Characteristic Curves of Two-Rate Overload Relay.*

No. 1 is the time-current curve for the high currents, and curve No. 2 for the running overloads. The two curves have a change-over point, which, as can be seen, is somewhat unstable.

There are two types of overload actions (i) magnetic and (ii) thermal. The former, as its name suggests, is designed around the amount of flux produced by a given current. Any greater value causes movement of a plunger or small armature, which, generally speaking, acts on the toggle lever in the case of hand-operated gear and in the no-volt circuit of push-button types. The second type is commonly actuated by a bi-metal strip which bends under the influence of a heating coil, and either opens the no-volt circuit or actuates some trigger mechanism. The bi-metal strip can either be heated by the main current passing through it, or, alternatively, it can be provided with a separate heater. The former type acts more quickly, but the strip may form a fuse itself. The latter type makes it possible to put sufficient mass into the heating element to avoid fusing, and, furthermore, enables the electrical manufacturer to use the same bi-metal strip with any size of heater, and thus assist in standardisation. It is therefore the more popular.

The no-volt feature is generally obtained by arranging for the switch to be spring loaded against closing, and retained in an engaged position by a catch, which forms part of or is attached to the armature of a small solenoid coil. Demagnetisation allows the catch to drop and the loaded spring forces the contacts apart.

Both these features, the no-volt and the overload protection, give a fairly adequate form of security against failure of voltage and overloading. The best modern practice calls for protection in all main lines. For instance, in dealing with a three-phase circuit, it is common practice to insert overloads in two of the phases only. This is acceptable in many cases, but three-phase protection has certainly more to recommend it.

Except in the case of small fractional horse-power motors, direct starting is not practised with D.C. motors on account of the very high torque and momentary current produced at starting. Resistance face-plate starters are common enough to need merely mentioning. A.C. motors of the squirrel-cage type are direct started up to 5 h.p., although with the centralisation of supplies the power supply authorities are being more flexible, and with large consumers motors of 25 h.p., or even larger, can be direct started without any difficulties arising. It all depends on the total load existing on the supply feeder. To cope with excess values of starting current on A.C. squirrel-cage motors, we have star-delta and auto-transformer starters.

As already stated, these starters reduce the voltage across the motor windings, with consequent reduction in starting current and torque, as indicated in Fig. 1. As regards the starters for slip-ring machines, these are of similar construction to those for D.C. motors, except that more than one section of starting resistance is required.

Control of Variable-speed Drives.—Alteration of speed is of paramount importance, especially with the introduction of high cutting speeds following the use of alloy tools and with a full production programme. Every job must be carried out in the minimum of time, and the correct speed is therefore very necessary. The machine tool manufacturer is faced with several alternatives. First, a change-speed gear-box, with a constant-speed motor, and, secondly, a variable-speed motor with no gear change, or, thirdly, a combination of the two, the number of changes on the gear-box being limited.

Should D.C. supplies be available, the shunt-wound motor with speed variation by means of a shunt field rheostat provides a very simple solution. The number of steps is only limited by the number of steps on the rheostat. In this case constant horse-power is obtained throughout the whole range of speed.

It is well known that a very large speed range can be obtained by the use of variable voltage control. This necessitates a D.C. supply. Unfortunately, with this system, usually designated as Ward-Leonard, a constant torque is obtained. In the case of a motor driving a cutting tool, making full use of the driving motor output, the metal removed is proportional to the speed, whereas is should be possible with full use of the tool to obtain at least the same output, irrespective of the speed. Possibly Fig. 7 will help to elucidate this. This graph

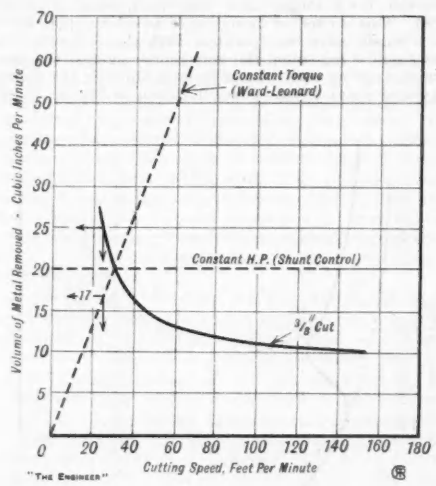


FIG. 7—*Output Curve for a Tool with a Two Hours' Life Cutting Steel.*

shows the output in cubic inches per hour obtainable from a tool cutting mild steel, assuming a tool life of two hours. The horse-power to drive the tool is proportional to the output for a given material. The ordinate scale can be regarded as horse-power. Take 30ft. per minute as the cutting speed, then the output with a $\frac{3}{8}$in. cut and 0·15in. feed will be 20 cubic inches per minute. Assume that this is equivalent to 20 h.p., as being necessary for a number of tools, then a D.C. motor having a constant horse-power and a speed range of 3 to 1 by shunt control, would not only be capable of dealing with the full output continuously, but, furthermore, if the minimum motor speed corresponds to 25ft. per minute with a maximum of 75ft. per minute, the overload on the motor at the minimum speed, with full output from the tool, *i.e.*, 25 cubic inches per minute, would be only 25 per cent. All motors of such a size, according to B.S.I. Specification No. 168, should withstand this overload for two hours.

On the other hand, with Ward-Leonard control, and the motor designed to give the same continuous output at 30ft. per minute, the overload at 25ft. per minute would be almost 50 per cent. The standard motor should not be called upon to withstand this for more than a few minutes. It can be assumed, therefore, that for general use the Ward-Leonard control cannot be economically employed to drive the cutting tool. Special applications will, however, receive consideration later.

Calculations of Horse-power to Drive Tools.

One fundamental formula can first of all be given :—

$$\text{h.p.} = \frac{P \times A \times S}{33{,}000}$$

where P = pressure in lb. per square inch on tool.
A = area of cut in square inches.
S = cutting speed in feet per minute.

If necessary, this can be easily converted in terms of pounds per hour.

$$\text{Output in lb./hour} = \underline{A \times S \times K \times 720}$$

where K = weight per cubic inch of metal removed.

$$\therefore \text{h.p.} = \frac{P \times \text{lb./hour}}{K \times 23{\cdot}76 \times 10^6}$$

Now P varies with various conditions, but can be given approximately as follows :—

Medium steel :	Brinell	No. 176 — $P = 0{\cdot}260 \times 10^6$	lb./sq. in.
Soft steel :	,,	No. 147 — $P = 0{\cdot}242 \times 10^6$	,,
Hard steel :	,,	No. 214 — $P = 0{\cdot}285 \times 10^6$	,,
Cast iron :	,,	No. 149 — $P = 0{\cdot}092 \times 10^6$	,,
,,	,,	No. 156 — $P = 0{\cdot}083 \times 10^6$	,,
,,	,,	No. 166 — $P = 0{\cdot}072 \times 10^6$	,,

These are taken from the report of the Lathe Tool Committee (Manchester Association of Engineers), October 1922, and Summary of Tests on Cutting Capabilities of Lathe Tools, December, 1928 (Manchester Association of Engineers, the Department of Scientific and Industrial Research, and H.M. Privy Council).

Other factors should be taken into consideration, as will be seen on referring to the above report, but for practical purposes the figures give a very close approximation to the power required.

Applications.

It is difficult to divide the types of drive into any sharply defined classes, but the following are suggested, and comments on the various applications are made.

(*a*) Constant-speed motor drives.
(*b*) Variable-speed drives.
(*c*) Reversing and reciprocating motor drives.

(*a*) *Constant-speed Drives.*—There are many machines which would be driven quite easily from a line shaft. Any speed change, if required, is effected by a change-speed gear-box.

(*b*) *Variable-speed Drives.*—Dealing first with A.C. supplies, one of the most common change-pole squirrel-cage motor drives is the sensitive drill. The speed is controlled usually by means of a two or four-positioned switch, either push-button or handle operated.

The A.C. commutator motor has been used to drive a lathe, but the application is special and, generally speaking, is found an expensive proposition. The control by means of a pilot motor is very simple, but adds to first cost. One disadvantage must be mentioned, and although it can be surmounted it adds considerably to the price. This is the necessity for returning to minimum speed setting each time the motor is stopped.

The D.C. drive for lathe headstocks is very popular when the supply is available. The shunt regulator is simple, low in cost and by adding a suitable relay it is possible to start up the driving motor with weak field settings. The horse-power output of the motor is constant throughout its range. This, unfortunately, is limited to four times the minimum, so that anything beyond this necessitates the introduction of a gear change.

Cylindrical grinding machines would appear to call for little comment, but in the past few years much attention has been given to the design of such machines. With regard to the wheel itself, this generally is constant speed although some method of increasing the revolutions per minute to compensate for wheel wear is desirable. The work head spindle, on the other hand, is required to work over a large range to deal with different diameters of materials. The power to drive the spindle is comparatively small, and several examples of variable voltage control can be seen in this country and on the Continent which entail the use of a small D.C. motor supplied by power from a generator driven at a constant speed by the main motor. The drive of the table is by a hydraulic pump and gear.

(*c*) *Reversing and Reciprocating Motor Drives.*—It can be safely stated that they form one of the most difficult drives in the machine tool trade. Here the Ward-Leonard control is used extensively.

It has been shown that a constant horse-power is ideal, but due to the simplicity, flexibility, and smoothness of control, the variable voltage drive for planers is extremely popular. In theory, the use of a reversing motor is incorrect, in that the inertia on the motor armature forms a large proportion of the total inertia in the machine. Even a heavy planer bed of, say, 30 tons, returning at a speed of 150ft. per minute, has only the same inertia as a D.C. motor of 12·5 h.p. (having a 2/1 speed range) running at 1000 r.p.m. Yet for the purpose of driving the machine, a motor of approximately 60 h.p. would probably be required. The return speed usually is obtained by shunt control, the output curve being as per Fig. 8.

It is customary to use motors having a speed variation

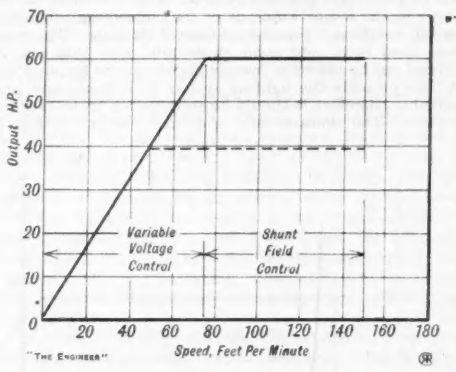


FIG. 8—*Planer Motor Output.*

of 2 to 1 by shunt control. Should a ratio of 3 to 1 by shunt control be chosen, as shown by the dotted line, it might be expected to reduce the size of the motor in proportion to horse-power output. As, however, the speed is also reduced at the same time, the torque remains constant, and the frame size is probably the same. Actually, due to the reduction in ventilation at the lower speed, the frame size may be increased. The generator supplying power, however, is certainly reduced because of the small horse-power output, and therefore the overall first cost would be lower. Against the 3/1 range, however, is the increase in difficulties in commutation, and the general practice to accept a shunt speed increase of 2 to 1.

As already mentioned, the fly-wheel effect of the motor itself is an extremely important factor. For being a large proportion of the total for the whole machine, it is obvious that much energy is expended not only in acceleration but deceleration of the armature alone. In accurate calculation it is necessary to determine the root mean square value of the power required over various cycles. To do this, the friction of the planer, the work done at the tool faces, and the kinetic energy of the various moving parts must be known.

It is generally understood that the output of a motor is some function of its D^2L, D being the diameter and L the length of the armature. In the past it was customary to design the motor with a large diameter and a short core length, which, as can be seen from the Fig. 9, produces a high moment of inertia. Recent progress in design has altered matters, so that it is now possible to install a motor of the same output, but with a very much reduced kinetic energy. Claims to an appreciable increased output by merely altering the design of the

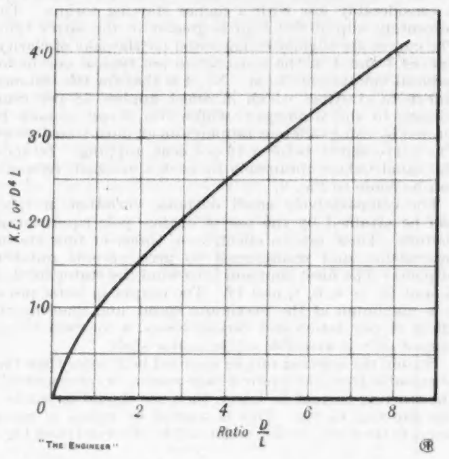


FIG. 9—*Curve Showing Dependence of Kinetic Energy on Ratio* $\frac{D}{L}$ *with Constant Output.*

motor have been made in some cases. The curve in Fig. 9 must be taken as only typical as there are factors in the actual design which may modify it.

Conclusion.

The future of the machine tool designers is undoubtedly going to be full of interest in the next few years. New designs are being developed, particularly for what might be termed "single-purpose tools." Electric drives will become more and more important, and in consequence close co-operation between the mechanical and the electrical engineer is extremely necessary. This has been found so advantageous in other countries that Great Britain has been in danger of falling very far behind.

To get the utmost from the completed article, it is absolutely essential for the machine man to take the electrical man into his complete confidence. The electrical manufacturer in these days is something more than a supplier of goods. He is a consultant, and as such will respect any confidential matter placed in his hands.

SIXTY YEARS AGO.

In December 1875 the men employed at the Erith shops of Easton and Anderson went on strike in protest against payment by piecework. Very, little of the work done by the firm in its ordinary course of business was of a nature lending itself to payment by the piece and for the most part it was its custom to pay day wages. Occasionally, however, when the conditions were suitable, it had resorted to the piecework system to a limited extent and the workers on those occasions had not objected to it. The trouble which led to the strike arose when the firm took a contract for a large number of fair leads for one of the dockyards. It proposed to pay the men engaged upon it by the piece. The men, however, objected to the extension of the system beyond those departments which had previously made resort to it and particularly to its extension to the firm's fitters, turners and erectors. The Amalgamated Engineers' Society and the Steam Engine Makers' Society supported the men and a strike took place. The engineering employers in those days were less closely organised for collective action than they are to-day. Nevertheless their representative body, the Iron Trade Employers' Association, at an early stage in the dispute realised that it involved a principle of national importance. It was held to be the beginning of a general movement on the part of the unions against the piecework system in general and it was believed that if the men succeeded at Erith other engineering works would be singled out for attack, one or two at a time, on the same ground until piecework was wholly abolished throughout the industry. The Employers' Association therefore threatened to declare a general lock-out unless the Erith strike were immediately brought to an end. Almost simultaneously Easton and Anderson gave the strikers until January 22nd 1876 to agree to accept such piecework as the firm thought proper. Failing such acceptance, they were told, they would be regarded as dismissed and would never again be given employment at the works. The men refused to yield and picketed the works to prevent the engagement of other workers. So far as we can gather from a study of our pages of that time the employers' action proved effective. The strike, it seems, ceased to be a weapon in the men's hands because the firm found it possible to obtain fresh workers who were willing to accept its terms. . . . This was not the only instance at or about the same time when bodies of workers expressed their hostility to payment by the piece. At Plymouth the South Western Railway had decided to erect a large terminus building in stone and to pay the masons and plasterers engaged upon it by piecework. The men, however, determined to have nothing to do with the system. They decided that if any foreman was found measuring up the work to see how much any man had done the job on hand was to be stopped immediately. The railway company took prompt action. It changed its plans and decided to build the terminus as a wooden instead of a stone structure. This course might have proved effective had not the carpenters in turn struck against piecework. We suggested, in commenting upon the situation, that the railway company might still try iron as another alternative but whether this solution was eventually adopted we cannot trace from any record in our columns.

Rail and Road.

THE Barkston, Grantham, L.N.E.R., accident of January 19th, when eight of the occupants of a ballast van lost their lives when their train was run down by two light engines coupled together, was inquired into by Colonel Woodhouse on January 24th.

THE platelayers' motor-driven trolleys are of such a build that they need to be turned on a turntable in order to enter their "garages" on the side of the line. The L.N.E.R. has now made an improvement in the trailer trolleys so that the seats, body, and chassis can be removed separately, so facilitating removal from the track without the use of turntables.

THE Board of Trade export tables for December last show that during the year locomotives to the value of £876,603 were shipped overseas; carriages and wagons to the value of £1,224,826; rails, £907,362, and wheels, metal sleepers, fish-plates, and miscellaneous materials, £1,840,997. The corresponding figures for 1934 were: £455,295, £973,853, £996,044, and £1,242,042 respectively.

ACCORDING to the Road Fund report for the financial year 1934–35, more than 1800 miles of new footpaths—equal to the distance by road from Lands End to John o' Groats and back—were constructed on the roads of Great Britain during the year; approximately 12,400 "Major Road Ahead" signs erected, and nearly 500 road junctions equipped with street traffic signals. The need of adequate banking on road bends has also been realised, and the bends on which superelevation has been provided number 6188.

A NOTE in the *Arthur D. Little Industrial Bulletin* discusses the use of rubber latex for the expansion joints in concrete roads. The note says rubber latex compounds of a creamy consistency that vulcanise in two weeks to a compressible elastic mass have been found to overcome many of the difficulties encountered with asphalt. Labour costs on the maintenance of the present asphalt joint are so great that a rubber latex bond which costs some 1200 dollars per mile for each lane of road is apparently a net economy. Experiments have been conducted over a period of more than two years, and while it is still too early to make predictions, apparently no serious drawback has been found, and both road engineers and rubber men are following the method with interest.

THROUGH hundreds of miles of wilderness, the province of Quebec's sparse railway communication may be extended over the rambling Laurentian Mountains to Labrador, opening for the province the first direct line to the Atlantic and creating the possibility of a new winter port. Plans for a new railway incorporated in a charter granted by the Quebec Legislature would push the line north-eastward from the growing Lake St. John region to a point nearest remote Cape St. Charles, on the Labrador Coast, just north of the Strait of Belle Isle. The charter was granted some years ago, but because of the depression action was delayed. Now the company hopes to start work in the near future. Construction of the railway would be over an 800-mile route, combining on a small scale all the difficulties that confronted the pioneers who carried the line of steel through the Rockies, and those who laboured to push through miles of muskeg, rock, and wilderness the line that has opened a sea route to Western Canada.

ENGINEERS of the Ministry of Transport have devised a traffic control scheme for Old Dee Bridge, Chester, which will increase the safety and usefulness of the bridge without involving any structural alterations. The solution to the problem has been found by allowing only one line of traffic to use the bridge and by installing vehicle-actuated signals to release alternately the traffic from north and south. A grant from the Road Fund towards the cost of installation is being made. To ensure that there will be the least possible delay to traffic, the signals are being so arranged as to distinguish between slow vehicles, such as horse-drawn vehicles, and fast vehicles. This is done by laying down at intervals along the bridge a series of five detector pads. Whenever a vehicle passes over one of these pads it is given an extension of time, and in this way the total length of time allowed for vehicles to clear the bridge is regulated according to the speed of the traffic. It has also been arranged that when the traffic is light the clearing period will be cut out altogether. The automatic variation in the length of the clearing period and its suppression when not required was worked out in detail by the Automatic Electric Company, which invented a new type of controller for this purpose.

THE railway services of the London Passenger Transport Board carried 2,000,000 passengers to and from the funeral of King George on January 28th. There were 2,000,000 carried also on Silver Jubilee Day, but the number was spread over nineteen hours. At the funeral the 2,000,000 were all carried practically before noon and in a highly concentrated area. The pressure on the latter occasion was more severe than anything experienced in the seventy years of the railways' history. Most of the passengers travelled between 5.30 a.m. and 8.30 a.m., and in the nine hours between 5 a.m. and 2 p.m. the Underground railways carried as many passengers as they carry in the nineteen hours of a normal working day. Hammersmith headed the list with 120,000 passengers in the nine hours; other representative stations were: Piccadilly Circus, 100,000; Liverpool-street, 100,000; Victoria, 80,000; Hyde Park Corner, 80,000; Waterloo, 60,000; Charing Cross, 60,000; Oxford Circus, 46,000. In a message of thanks to the staff, Lord Ashfield said that the use made of London Transport on that day was considered by the L.P.T.B. to be an impressive demonstration of the confidence which the public reposes in the Underground system on great occasions. In creating that confidence the loyalty of the staff to the public and to the Board has played an important part. There was a notable expression of this loyalty during the Lying-in-State at Westminster, when, to serve the mourners, it was decided to run special services and to keep Westminster Station open all night. On that occasion there was no lack of volunteers to undertake additional duties after normal working hours. That was the first time an Underground station had been open all night.

Miscellanea.

DURING 1935 motor car exports from this country were valued at £12,108,102, as compared with £11,332,950 last year.

IN succession to Mr. C. H. St. John Hornby, Professor Frank Horton has been appointed Chairman of Chelsea Polytechnic Institute.

SUNDAY, February 23rd, will be the fiftieth anniversary of Charles Martin Hall's production of his first globule of metallic aluminium by the electrolysis of aluminium oxide in a fused cryolite bath, in his father's woodshed at Oberlin, Ohio.

THE Department of Overseas Trade announces the cancellation, out of respect for the memory of his late Majesty King George V, of the banquet which, by the courtesy of the Lord Mayor, was to have been given by his Majesty's Government at the Mansion House on February 17th to mark the opening of the British Industries Fair of 1936. The Fair itself will be held in accordance with previous arrangements and will open on February 17th.

ON Tuesday last we were present at South Africa House, when a sound film describing the Iscor Steel Works of the South African Iron and Steel Industrial Corporation was shown. Entitled "The Story of African Steel," the film first recorded the opening of the works, and then, step by step, covered each phase of steel manufacture from the mining of the iron ore, coal, and other raw materials to the final rolling of rods, rails, &c. The film was of very great interest, and those who produced it are to be congratulated upon its general excellence. The only fault which at times somewhat detracted from the interest of the picture was the recording of the noises, which, although present in steel making, were rather unnecessarily accentuated in the reproduction.

CIVIL engineers and contractors will learn with deep regret of the death of Sir A. Lindsay Parkinson, the senior partner of Sir Lindsay Parkinson and Co., Ltd., civil engineering contractors, London. Sir Lindsay, who died at his home in Blackpool at the age of sixty-five, began business forty-eight years ago in a small way at Blackpool and by his initiative and untiring energy, he built up one of the largest contracting firms, which in recent years has carried out, among others, the following engineering works:—The Liverpool–East Lancashire road; the Purfleet–Tilbury road; the new Grimsby Fish Docks; Jersey Harbour; the new breakwater, Leixoes, Portugal; the Barnet By-pass road, and the Famagusta Harbour, Cyprus. Sir Lindsay was a great sportsman, and his death will be widely mourned.

CALCULATIONS and observations at flood times on the international highway bridge over the Rio Grande between Laredo, Texas, and Nuevo Laredo, Mexico, showed that the old railing of heavy concrete construction offered as much as 50 per cent. of the total resistance of the structure to the current. It was therefore decided, says *Engineering News-Record*, to replace the old railing with one of aluminium, which was removable. The new railing consists of sections averaging 10ft. in length and 46in. in height above the deck, which are fitted into galvanised steel bracket plates permanently fastened to the bridge. There are two of these plates to each pair of abutting railing end posts, bolted to the sides of the sidewalk facia beams by six ¾in. steel bolts solidly grouted into the concrete. The posts are made secure in the brackets by galvanised wedges bolted to one of the abutting railing end posts through slotted holes to facilitate adjustment and to prevent loss of the wedges when the railing is removed.

SUNDAY, February 2nd, was the fortieth anniversary of the day on which Marchese Marconi arrived in England with his crude apparatus to demonstrate to the G.P.O. and other Government Departments the possibility of communication without the aid of wires. In June of 1896 he lodged his application for the first British patent for wireless telegraphy, and in July of that year gave his first demonstration before Sir William Preece, then Chief Engineer of the G.P.O. This was over a distance of 100 yards, but subsequent experiments on Salisbury Plain, on the Bristol Channel, and elsewhere showed possibilities of communication over much greater distances. Within a year of his coming to England Marchese Marconi had proved that distances up to 10 miles could be covered. During the following year this distance was doubled, and within five years the Atlantic had been spanned by the transmission of "S" signals from Poldhu in Cornwall to St. John's, Newfoundland. From these beginnings modern wireless developments, including broadcasting and the possibility of television, have emerged.

CAESIUM belongs to the alkali metals, the common ones in this group being sodium and potassium. In its simple salts and simple chemical reactions caesium resembles potassium very closely. However, in plant life, and in living cells in general, potassium is an essential constituent, whereas caesium is a poison. The element was first isolated by Bunsen and Kirchof in 1860. In nature it is relatively rare; it occurs in the mineral pollux or pollucite, which is a hydrated aluminium caesium sodium silicate containing from 30 to 36 per cent. caesium oxide. This is found in Hebron, Maine, and in Germany. Caesium is recovered from this mineral by treatment with hydrofluoric acid and then precipitated out of solution by the addition of antimony trichloride. Metallic caesium can be prepared by the interaction of caesium chloride or caesium carbonate with metallic magnesium or metallic calcium in the presence of hydrogen. In thermionic valve factories other methods have been introduced; thus Philips uses the nitride method. At about 150 deg. Cent. nitride of barium dissociates, furnishing barium metal, which, on further heating to about 350 deg. Cent., reacts with caesium chloride to produce caesium metal. Practically all the caesium produced to-day is consumed in the production of photo-electric cells. The caesium cell is about fourteen times as sensitive as the older hydrogenated potassium photo-electric cell. Caesium metal melts at 26 deg. Cent., as compared with sodium which melts at 97·5 deg. Cent. Caesium reacts with oxygen and water explosively; its hydroxide is the most basic hydroxide known. The atomic weight is 132·91.

Air and Water.

DURING January seven vessels, aggregating some 19,591 tons, were launched from Clyde shipyards.

A WIRELESS direction-finding station, costing £2500, is to be erected at the Southampton airport at Eastleigh.

AT present, the airway system of Pan-American Airways covers some 33,000 miles, and it is expected that in May next an additional 8706 miles of route will be added.

IT is proposed by the Metropolitan Water Board to open new laboratories at Barrow Hill, Regent's Park, as the present premises are inadequate. The estimated cost of the new establishment is £70,000.

A PLANT for the manufacture of stainless steel is being erected at Larvik, in Norway. Production will shortly be begun and an ultimate annual output of 25,000 to 30,000 tons of rustless steel is expected.

THERE are at present some 6000 men working on the fitting out of the Cunard White Star liner "Queen Mary." It is expected that by the end of this month 1000 of these men will have completed their work and be paid off.

DURING 1935, the Postmaster-General announces, the total weight of letters sent from this country by air mail was 187 tons, and the total weight of air parcels was 79 tons. The corresponding weights for 1934 were 122 tons and 74 tons.

ACCORDING to the Air Ministry's recently issued quarterly list of municipal airports, there are now twenty-seven towns with licensed aerodromes, eleven towns have purchased sites, four towns have reserved sites in their town-planning scheme, and 112 towns have sites inspected.

A REPORT from Australia states that the Commonwealth Government has rejected the British proposal that all mails handled by the England–Australia air mail service shall be carried without surcharge in flying boats. The Government contends that while in some ways the proposal is attractive, it is irreconcilable with the conditions and requirements of Australia.

WE regret to record the death of Sir Joseph Lowrey, former director and secretary of the London Salvage Association. Sir Joseph, who was seventy-six years of age, was appointed secretary of the Salvage Association in 1897, after having served with the Merchants' Marine Insurance Company, and on December 1st, 1925, he was appointed director and secretary of the Association. He retired on June 30th, 1932, since when he has been engaged in arbitration work.

THERE are at present 157 ships, totalling some 531,700 registered tons, under construction in German shipyards; 76 of these vessels are for German owners, and the remaining 81, with a tonnage of 311,380 tons, are for foreign owners. According to the *Financial Times*, the Unilever Company heads the list of foreign commissions, as it has ordered 14 motor ships, 13 steam trawlers, and 6 whale catchers, having a total tonnage of 97,650 tons, to be built in German yards.

THE seventeenth Royal Air Force Display will be held at Hendon on Saturday, June 27th. The Display is the culmination of the Royal Air Force training season. It thus provides an opportunity for the public to observe the annual progress of service aviation, and it also enables the development of new types of service aircraft to be exhibited, both on the ground and in flight. The precise nature of the programme is now under active consideration in the light of the conditions which will obtain consequent upon the expansion of the Royal Air Force.

THE new terminal aerodrome at Gatwick is equipped with every lighting device for night flying operations. In the main, the equipment is similar to that installed at Croydon, and comprises a G.E.C. neon beacon and beacon tower, wind indicator, boundary and obstruction lights and poles, cables, switchgear, and controlling apparatus, &c. At the new Brighton, Hove and Worthing municipal airport at Shoreham, Sussex, the lighting equipment includes a G.E.C. 9-kW three-tier portable landing floodlight, which is moved to various parts of the aerodrome to enable pilots to land from behind it. The floodlight is moved from place to place by tractor, and connected to various plug points on the ring main underground supply system.

A RECENTLY issued Air Ministry publication listing the numbers of registered civil aircraft in Great Britain and various foreign countries shows that the United States has the largest number of civil aircraft registered as owned by regular air transport companies, the total being 518 machines. Next comes Germany with 244 machines, France with 221 machines, and Great Britain and Northern Ireland with 168 machines. The total number of registered civil aircraft in these same countries is:—United States, 7202; France, 2201; Germany, 1809; Great Britain, 1577. The following are the largest owners of registered civil aircraft in this country:—Imperial Airways, 43 machines; British Airways, Ltd., 28 machines; Jersey Airways, 10 machines; and Portsmouth, Southsea and Isle of Wight Aviation, Ltd., 10 machines.

IN a recent paper before the North-East Coast Institution of Engineers and Shipbuilders, Mr. W. E. Lewis discussed the protection of ships' hulls from marine corrosion. He said that sea water was a typical aqueous solution of metallic salts for the conduction of electricity, and with a steel vessel fitted with brass or bronze propellers immersion in sea water induces a difference of potential between the two metals, that upon the steel being the higher under such a condition. Electric energy passes from the steel and causes the hull structure to corrode. If, however, a zinc slab be fixed in electrical contact with the steel surface, the difference in potential between the zinc and the brass will be greater than that between the steel and the brass. Under such conditions the electric energy will emerge from the submerged surface of the zinc slab, and the steel structure will be protected against corrosion at the expense of the renewable zinc. In order to get the maximum benefit from such a protective measure, the zinc slabs should be attached to the hull structure at those points where maximum corrosion would occur were no slabs fitted.

THE DUMBARTON VALVE WORKS OF BABCOCK AND WILCOX, LTD.

(For description see page 146.)

FIG. 15—MEDIUM MACHINE SHOP

FIG. 16—BRASS MACHINE SHOP: MILLING MACHINES AND LATHES

FIG. 17—HEAVY MACHINE SHOP

FIG. 18—BRASS MACHINE SHOP: CAPSTAN LATHES

The Engineer

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Contents.

THE ENGINEER, February 7th, 1936. PAGE

A SEVEN-DAY JOURNAL ... 141
AMERICAN BEACH AND SHORE PROTECTION WORKS. No. IV. (Illus.) ... 142
BRITISH MACHINE TOOL MAKERS. No. II. (Illus.) ... 144
THE DUMBARTON VALVE WORKS OF BABCOCK AND WILCOX, LTD. (Illus.) ... 146
LITERATURE ... 147
BOOKS RECEIVED ... 148
THE ELECTRIC CONTROL OF MACHINE TOOLS. (Illus.) ... 148
SIXTY YEARS AGO ... 150
RAIL AND ROAD—MISCELLANEA—AIR AND WATER ... 151
LEADING ARTICLES—
A Survey of Aeronautical Progress ... 153
The General Shop ... 153
SCIENTIFIC WORKERS OF THE PAST GENERATION ... 154
MECHANICAL STOKING FOR SCOTCH MARINE BOILERS. (Illus.) ... 157
THE GREAT WHINSTONE DYKE ... 159
LLOYD'S REGISTER OF SHIPPING. (Illus.) ... 159
THE INSTITUTE OF METALS ... 160
FRACTIONAL HORSE-POWER MOTORS. (Illus.) ... 160
HIGH-SPEED CRAFT FOR THE TIMOR SEA. (Illus.) ... 160
BRITISH STANDARDS INSTITUTION ... 160
CATALOGUES ... 160
GLOW-TUBE CLOCK DIALS. (Illus.) ... 161
A SELF-CONTAINED OIL BURNER. (Illus.) ... 162
PERSONAL AND BUSINESS ANNOUNCEMENTS ... 162
CONTRACTS AND ORDERS ... 162
CANADIAN ENGINEERING NEWS ... 162
LAUNCHES AND TRIAL TRIPS ... 162
MARKETS, NOTES AND NEWS ... 163
CURRENT PRICES FOR METALS AND FUELS ... 164
FRENCH ENGINEERING NOTES ... 165
BRITISH PATENT SPECIFICATIONS. (Illus.) ... 165
FORTHCOMING ENGAGEMENTS ... 166

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CHANGES OF ADDRESS.

**** Will subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

A SURVEY OF AERONAUTICAL PROGRESS.

MANY of our readers can, like ourselves, cast their minds back to the birth of practical flying and survey in memory the progress made in aeronautics during the past quarter of a century. Three clearly defined periods can be perceived, the pre-war period, the war period, and the period which has elapsed since the end of hostilities. The pre-war period, certainly so far as this country is concerned, may be regarded as having begun on that historic Sunday towards the end of July 1909 when Blériot flew across from France and proved to us that, tactically, we no longer inhabited an island. In recollection those five early years seem now to have been a period when a few daring individuals ascended in crazy experimental machines, flew them in almost total ignorance of the factors governing safety in flight, and descended without disaster if they were lucky. The four war years, in backward vision, appear as a period during which the infant science and industry of aeronautics was subjected to highly intensive development. The rate of progress appeared to be forced far beyond its natural pace and at the end of the period the advance made seemed to be almost fantastic. By the beginning of 1919, when the third period started, aeronautics, in the opinion of many people, had reached or had approached a stage of development beyond which further opportunities for great or rapid progress could not be expected. Nevertheless the seventeen years which have since passed have witnessed the development of aeronautics continued with undiminished vigour, almost, it might seem, with ever accelerating vigour. In whichever direction we look, whether to speed, endurance, load-carrying capacity, design, construction, or equipment, we appear to-day to have advanced farther beyond the 1919 stage than that stage was in advance of the early beginnings. An end more important than the attainment of mere historical accuracy will, we think, be served if we check against recorded facts this general impression of the progress made in aeronautics during the past twenty-six years.

It is as easy unduly to extol as it is to belittle the progress achieved in the five pre-war years. Without exaggeration, however, we may now accord to it a high order of importance. It is certain that within the period are to be found the germs of many developments credit for which is commonly assigned to later years. It saw not only the foundation of the Royal Flying Corps—in 1912 with an initial establishment of 131 aeroplanes—but the beginnings of more than a dozen of the firms included to-day in the British aircraft and aero-engine industry. On the constructional side we may recall the fact that the British military aeroplane competition held in August 1912 was won by a machine—the Cody biplane—which was built very largely of bamboo. We must not, however, allow that fact to dominate our recollections. It should also be noted that contemporaneously or very soon afterwards spruce, ash and plywood construction became established on lines which remained almost standardised until after the war was over. Further a considerable number of aircraft designers—particularly in France—turned their attention to steel as a structural material. At the Paris Aero Salon held in October 1912, out of forty-five representative machines exhibited the framework of fourteen was composed of wood, that of twenty-one of wood and steel, and that of ten entirely of steel. As a means of controlling lateral stability our impressions of the period are to-day perhaps dominated by the remembrance of wing-warping. Actually wing-warping went wholly out of favour, in preference for the use of ailerons, long before the end of the period. It was abandoned in the march of progress and not simply because it fell within the patent rights claimed by the Wright brothers. Concerning the general theory of flight the work of Lanchester, Bryan, and Greenhill—to name only three British investigators—had done more than lay the foundations of modern doctrines. Stability problems were studied theoretically, experimentally, and practically and the rival claims of automatic *versus* inherent stability were closely debated. One at least of the several forms of "automatic pilot" which we know to-day, the Sperry gyroscopic equipment, was first tried during the close of the pre-war period. Within those same years the almost universal early practice of pushing machines through the air by means of a propeller disappeared in favour of a nearly universal use of tractor screws. Towards the end of the period the fitting of quick-firing guns on aircraft seemed to threaten a return to the employment of propellers. By 1913, however, interrupter gear had been invented to enable the gun to be fired through the airscrew disc. These facts, few as they are, should be sufficient in some measure to correct our perspective of the progress made in aeronautics during the five years preceding the war. Of the developments effected within the four war years it is not possible to present an adequate picture in a few words. In August 1914 we sent to France between fifty and sixty military aeroplanes, mostly of the B.E.2 type—"Blériot Experimental"—a general service two-seater biplane designed and produced at the Royal Aircraft Factory. These machines, equipped with an 80 h.p. engine, had a speed of 50 to 60 miles an hour and could climb to 10,000ft. in a little over thirty minutes. By the end of the war we were producing many highly specialised machines in vast numbers. Typical of its class was the Sopwith fighting scout capable of rising to 10,000ft. in 8¼ minutes and of flying at that height at a speed of 128 miles an hour. At the other end of the scale there was the Handley Page long-distance night bomber driven by four 360 h.p. Rolls-Royce engines and carrying a crew of nine together with 1200 gallons of petrol—or sufficient for a flight of nearly sixteen hours' duration. Great as was the advance, it was achieved by no revolution in design or methods of construction but almost entirely by attention to detail combined with a notable development of the aero engine. Structurally the aeroplane of 1918 closely resembled that of 1914 in its dependence upon wood, glue, screws, piano wire, fabric, and rubber. Throughout the war, for production reasons, the "all-metal" aeroplane was shelved until just towards the end when the increasing scarcity of suitable aircraft timber induced a revival of interest in it. Of the progress made since the end of the war we need not write in any detail. For a time constructional methods continued along the lines followed during the period of hostilities. At the Aeronautical Exhibition held in London in July 1920 the machines shown illustrated the high development of performance achieved during the war but with one exception—the Short "Silver Streak" all-metal biplane—they failed to reveal any radical departure from the constructional methods of the late pre-war and war years. The Short machine was the only one exhibited which could be accepted, on critical examination, as a satisfactory engineering structure. Even it, however, was before its time for it was not until 1925 that the Air Ministry announced its intention of insisting upon metal construction for all military aircraft. Since those days continued progress has been made both as regards performance and construction while general design has recovered the fluidity of the early days. Military aircraft with speeds of 260 miles an hour are to-day not regarded as exceptional, in special machines speeds of over 400 miles an hour have been exceeded, huge machines carrying forty or more passengers are in regular service on civil air routes, the trip from England to Australia has been flown in less than three days and the construction of flying boats weighing 200 tons is being seriously considered.

The significance to us to-day of this survey of aeronautical progress during the past quarter of a century lies in its bearing upon the effort now being made to restore our air strength to a level of safety or supposed safety. At the close of the war Great Britain was predominant in the air although during its course there were periods when, to our grave peril, we did not hold the command which we finally exercised. So long as ascendancy depended upon the possession of aircraft of superior performance and technical characteristics, the balance swung from side to side. Our final predominance was secured and made unchallengeable by the overwhelming number of aircraft which we threw into the contest. By November 1918 our output of aircraft had reached a rate in excess of 24,000 machines a year. For the succeeding year's campaign which was never fought plans were ready for an output of over 40,000 aeroplanes. These figures are vouched for by Mr. Winston Churchill who was Minister of Munitions at the time. To-day the Government's programme of expansion is planned to give us a year or so hence an Air Force with a total strength of something under two thousand first-line machines and, counting all types of aircraft and normal replacements, involves the production, probably, of about two thousand new aeroplanes within a period of twenty-two months. From the point of view of construction and performance the machines will be very far in advance of those of the war period. We must not, however, repose our safety on technical excellence alone. If, unhappily, we should ever again be engaged in a life-and-death struggle for our national existence it will not be the technical excellence of our aircraft but our ability to produce machines in vast numbers that will save us. In aerial warfare the advantage to be derived from the introduction of aircraft of superior characteristics is short lived. In another war the opportunity of introducing aircraft of improved performance will be much less than it was in the last one which coincided with a period in the history of aeronautics which provided abundant openings for advance. Numbers, and numbers alone, will decide the issue. We recognise to the full the impossibility of maintaining during peace an output of military aircraft on a scale adequate to meet war conditions. It is none the less disquieting to note that the Government's programme of expansion calls for an output approximately equal to one twenty-fourth of the rate actually reached in 1918 and to about one-fortieth of that planned for 1919.

The General Shop.

AMONGST the many things which occupy the mind of the practical works manager there is perhaps none pleasanter than the devising of methods of carrying out exceptional work with existing equipment. It calls for the exercise of the mechanical engineering imagination, and for a display of ingenuity which is denied to those whose output is exactly fitted to the equipment and the equipment to the output. The manager of the specialised shops lacks these pleasures, and even the tool-room on which such work now-a-days devolves has little more to do, in all save a very small proportion of cases, than make gauges by standardised methods, devise cams, or work out the best form, duty, and order of use of cutting tools. They flourish in the atmosphere of the general shop, and are often found blooming in repair yards and on repair jobs. We recall an example which occurred in foreign waters during a certain Balkan war. The work involved the re-turning of the forward journals of the two main turbines of a destroyer. Usually the rotors and shafts would have been lifted and put in the lathe. As an alter-

native the shafts would have been barred slowly round by hand or, as in many a reciprocating repair job at sea, by fitting up a donkey or winch engine to provide power. In this case a young and ingenious mechanical engineer—how well and truly the name fits such work—revolved the turbines slowly under their own astern steam and turned the journals so true that on examination later the correction necessary was found to be hardly appreciable. Some of our readers will remember the late Mr. W. H. Morley, of Cole, Marchent and Morley, one of the cleverest mechanical engineers of his day. We visited him once at Bradford, when he was busy on the construction of an engine whose dimensions were far outside the capacity of his plant and well recall the admiration and pleasure aroused by the devices and makeshifts he employed to accomplish the work. Such cases are not rare. It has been said that the amateur mechanic is a man who achieves with inappropriate means what the professional hardly dares to attempt with specialised equipment. But just as the amateur has to be a good mechanical engineer within his limitations, so the professional mechanical engineer remains at heart an amateur in the pleasure he derives from calls made upon his ingenuity and resourcefulness in the prosecution of his work.

It is because the "general" shop offers such opportunities of this kind that it was at one time regarded as the best training ground for mechanical engineers. Fortunately, many such works remain and young men who desire to become "mechanical" engineers rather than "production" engineers might do worse than seek them out for the serving of their time. Many are rough and ready; the proportion of modern to old tools is small, and it is only by experience that the user learns where the best spots on the lathe bed are and what parts of the lead screw are to be avoided when screw cutting. Often the men are like the machines. Rather rough, but exceedingly knowledgeable in the arts and crafts of the wheelwright. Intermediate between these and specialised shops there are hundreds of factories up and down the country in which a surprising variety of work is undertaken and in which modern high production conditions are absent. They are, as we say, admirable training grounds for the genuine mechanical engineer. They are, moreover, a very valuable asset to the industry. In the early days of any novel mechanical invention it is in a quite unsuitable condition for the specialised shop. It goes, therefore, to the general shop, where the initial stages in its development may be undertaken. No new mechanical invention is perfect from the moment it leaves the drawing board. It always reveals some defects, either in design or operation. An enormous amount of very valuable experience is there for the observer who has eyes to see, and who, perhaps assists in correcting the primary defects. This is a form of training which is valued by engineers who served their time when specialised production methods were much rarer than they are now. No doubt a new type of man is needed to meet the new conditions, but it may be doubted if the real love of workshop practice which characterises older engineers is so often found in those of the present generation whose first thought has to be organisation and output.

We have said that the general shop is an asset to the industry; we might add that it is not an uneconomical one. The fact that general purpose tools take the place of specialised tools prevents any machine being idle for long periods because work of the kind for which it is designed is lacking. Moreover, it is generally found that many of the machines are elderly, if not old. They have been written off long ago; there are no standing charges on them, but in the hands of men who are familiar with their little idiosyncrasies they are still capable of good work. The buildings too, the offices, and the organisation are generally out of date; but cheap. For these and other reasons such works are often able to put in quotations much lower than those presented by firms burdened with high "overheads." A serious drawback to such works is that with few assets and small reserves they rely very greatly upon the personal zeal of one or two men. They have very little momentum and often enough seem to carry-on rather by the grace of God than their own endeavours. They are, no doubt, destined to diminish with the continual spread of modern production methods, but some of them will always be needed, and unless the apprenticeship system is as doomed as a recent discussion at the Junior Institution seemed to indicate, then it is to be hoped that a sufficient number of general shops will always remain as the training ground for your true mechanical engineer.

Scientific Workers of the Past Generation.*

By LORD RAYLEIGH, F.R.S.

THERE is a difference of opinion as to how far personal idiosyncrasies and details of private life are worthy of record when they have little direct bearing on results. For my part, I think that the history of science is quite as much involved with the personalities of the men who have made it as is any other kind of history. Those who have had the good fortune to be in personal contact with the great workers of the generation above them should not neglect to record what they think may possibly be valued by posterity. There is no doubt that this duty has been too little regarded in the past. It is hard to realise when one is young that what we see to-day may be gone to-morrow and irretrievably forgotten the day after; and still harder to realise how eager posterity may be to know it.

LORD KELVIN, O.M., 1824–1907.

Lord Kelvin's mental activity and vigour were at all times most remarkable. He never seemed to be tired, or disinclined to discuss any scientific subject that might come up, and was always ready to do calculations in any spare moment. These were done in a quarto notebook, his famous "green book," which he carried for the purpose. He wore tail coats with large side pockets, rather like a gamekeeper's pockets, in one of which the book was kept. His work was done in a large and rather unformed, but perfectly unambiguous handwriting. If there was anything Lord Kelvin avoided, it was cloudiness of expression; and the legibility of his handwriting was, in my mind at least, associated with this trait. The "green book" was produced, and the calculations proceeded with, on what might seem most unsuitable occasions. He seemed to find distractions rather helpful than otherwise, and would bring his work for preference into the drawing-room where ladies were gossiping, rather than avail himself of a quiet room. He would join in their conversation at intervals. In the laboratory, while waiting for something to be got ready to show him, the green book was produced, and I have on occasion been pressed into service to look out logarithms for him, and read them out, while he entered them. To be as insensitive to interruption as Lord Kelvin is a very valuable gift, and an unusual one. He did not always realise that other people lacked it. I have heard that there was a saying in the natural philosophy department at Glasgow that "the Knight [Sir William Thomson] cometh, when no man can work."

Lord Kelvin's engineering methods were interesting and characteristic. He had probably never had practical familiarity with the use of tools; indeed, it is not easy to visualise him as successfully driving home a screw; though one who, like myself, only knew him as an old man can hardly judge, and it is to be remarked that in his youth he was a successful oarsman, and played well on a wind instrument, both of which involve the appropriate kind of personal dexterity. His insight into the essentials of an engineering problem was, needless to say, very great, and his descriptions of his inventions, such as his compass and his sounding machine, are models of what such descriptions should be. They were composed with great care, and I have heard that in writing them, and in composition generally, he would sometimes pause for long periods before he could find the right word, or shape a sentence in the way that would satisfy him.

In designing his instruments and other mechanical constructions he did not make use of machine drawing. His method was to get something actually made and then criticise it, and have it modified accordingly. This plan had its inconveniences. When long afterwards it was desired to copy Lord Kelvin's tide predicting machine, it was found that no drawings of the rather elaborate mechanism had ever existed; and I believe that it had to be drawn out *de novo* from the existing machine. I believe, too, that his electrical instruments were made in the same way, being built up on a mahogany board from his verbal directions.

The view was sometimes taken, notably by Tait, that it was a prostitution of Kelvin's great abilities to devote himself to engineering and invention. It is doubtful, however, whether this view is really tenable. His brother, Professor James Thomson, cared mainly for engineering, and we may well suppose that Kelvin, too, had a strong natural bent in that direction. This is not inconsistent with his keen appreciation of the financial benefit of his inventions.

Lord Kelvin's mind was not readily satisfied with any theory which did not lend itself to the formation of a mental picture. He required mechanical analogies, and it was perhaps partly for this reason that he was so much dissatisfied with the electromagnetic theory of light, which (in some moods at least) he did not consider could rank as a theory of light at all. His point of view was difficult to grasp, but one day when he was talking in this general sense, I ventured to remark that it seemed to me that at any rate it was a great step to have shown that the velocity of light could come out of electrical measurement. Lord Kelvin did not seem to admit that this remark was at all to the point when Maxwell's theory was under discussion. I asked whether it was not true that Maxwell had been the first to point out this relation and had he not done it in connection with his theory. Lord Kelvin said no, it had first been pointed out by Kirchhoff, who was discussing conduction along wires. Needless to say that he was quite right, though I have only identified the passage with the help of Sir Joseph Larmor, while writing this address.

Lord Rutherford reminds me of the following incident, of which I am not altogether proud, but which ought to be recorded as showing Lord Kelvin's complete freedom from self-consciousness and his love of truth. It was in May, 1904, when he and other scientific friends, Rutherford among them, were paying a visit to my parents. Lord Kelvin was enthusiastic in his interest in radioactivity, but much averse to Rutherford's views which regarded the energy as derived from atomic sources. Lord Kelvin considered at that time that the energy was drawn from the surroundings in defiance of the second law of thermodynamics, and he would sometimes say, when discussing the matter with laymen, that he had hoped to go down to posterity as having formulated this law, and now he was compelled to admit that it was mistaken! He was arguing emphatically with Rutherford and myself against the atomic origin of the energy; so far as I remember he maintained that it was self-contradictory to appeal to atomic disintegration, the very definition of an atom, and the derivation of the word, implying that it did not disintegrate. I was enthusiastic for Rutherford's view, and with some lack of proper respect and deference I asked Lord Kelvin if he would make a bet of five shillings with me that within three (or it may have been six) months he would admit that Rutherford was right. He seemed to be delighted with the proposal, and told the ladies about it, saying that he felt pleased that such confidence was placed in his good faith; for (he said) it was only by his own voluntary admission that he could possibly lose his money.

Within the allotted period Lord Kelvin's views had come round, and at the meeting of the British Association in the autumn of that year he made a public pronouncement in favour of the internal origin of the energy of radium. I certainly never expected to hear any more about the bet, but next time I saw him, he came up to me at once and said: "I think I owe you five shillings. Here it is!"

However violently Lord Kelvin disagreed with people on scientific matters (and it was obvious that he did not mean half of what he said—if he had done so their views would not have been considered worth his powder and shot) he was always most careful not to say or write anything that would needlessly hurt their feelings. He was essentially courteous, and rightly expected to receive courtesy in return. On the occasion of the jubilee of Sir George Stokes' professorship at Cambridge, he got up among a surging crowd of people at an evening reception at the Fitzwilliam Museum and gave an extempore address on Stokes' scientific career. What he said was probably over the heads of the audience, even if they had been well able to hear it, which they were not. As might be expected under the circumstances, they soon began talking, and Lord Kelvin did not conceal his anger.

Indeed, he was not very apt at adjusting what he said to the capacity of his audience. He said the thing because it interested him, rather than because it was particularly likely to get "across the footlights." Very often this did not matter. His own interest in what he was saying was infectious, and kept his audience pleased. Young ladies whom he met in society would be delighted to receive his confidence in this way. On the other hand, I remember Mr. Joseph Chamberlain remarking that when scientific men were good enough to explain to him something of their problems and conclusions he could usually understand, but that Lord Kelvin left him completely mystified.

In his prime, Lord Kelvin cannot have been wanting in boldness of conception and faith in the possibility of success in heroic enterprises. His work in connection with the Atlantic cable is evidence of this. In old age he became more sceptical. He was curiously positive in his hostility to the conception of an aeroplane as a practical thing and he did not live quite long enough to see his views falsified. Motor cars he did see, but he did not like them, and was very emphatic in maintaining the wisdom and necessity of the early law which limited the speed to 10 miles an hour.

These reminiscences have necessarily dealt in the main with Lord Kelvin as an old man, for it is only so that I knew him. Many of them, I am afraid, reveal some weaknesses that are incidental to that period of life, and those who knew him in his magni-

* The Physical Society, excerpts from the presidential address, January 24th, 1936.

ficent prime would have been able to draw a portrait worthier of the subject. Nevertheless, there was much to admire in his old age, particularly from the human point of view. He was as enthusiastic as a boy, and entirely unspoilt by his success in life, and, indeed, apparently unconscious of it. To over-emphasise his own achievements or to dwell on them at all except in so far as they were interesting and relevant in themselves was a thing quite foreign to his point of view. The impression he generally produced on strangers was that of a dear old gentleman, and further acquaintance did not tend to change it.

SIR JAMES DEWAR.

It is no secret that Dewar was quarrelsome. So far as I am aware those who were most conversant with the circumstances of the various quarrels generally considered him to be in the wrong. Nevertheless, he was essentially kind-hearted, and if his tongue was rough, he was ready enough to respond to a friendly advance when he had cooled down, and, I suspect, attached little importance to what had passed, considering that hard words break no bones.

He was a bad sleeper, which explains and excuses much. I have heard it said that he was glad to get even three hours. He was something of an amateur pharmacologist, and had a special sleeping mixture of his own composition, which he took regularly, and sometimes recommended to his friends.

He was a generous man, and if anyone with whom he was associated needed help he gave it unstintingly, and would not listen to a word of thanks.

His rooms on the top storey, those which had formerly been occupied by Faraday, were a centre of hospitality after the Friday evening lecture.

Dewar's training had been primarily that of a chemist. His earliest investigations were on organic chemistry, but in addition he was a man of wide knowledge and essentially original scientific outlook. It was difficult to get much insight into his mental processes by talking to him, or even by listening to his lectures. He had no notion of unfolding his views in logical order, or of clearly explaining by what train of thought he had arrived at them. But, however mysterious its origin, there was no doubt of the value of his inspiration. The invention of vacuum-jacketed vessels naturally occurs to every one, and if they had come to be popularly called Dewar flasks instead of thermos flasks his fame would doubtless have penetrated to a very wide public. Dewar's earliest publication of the idea of a vacuum vessel dates back as far as 1874, long before his successful use of it for liquid air in 1893. There is no justification for any suggestion that he had been anticipated in the matter.

The use of charcoal cooled in liquid air for producing high vacua and for isolating helium was an invaluable laboratory method, and contributed much to the success of the earlier researches on positive rays, and on the rate of generation of helium from radio-active bodies. Its value is now diminished owing to the modern invention of other methods of rapidly producing high vacua, but is still by no means negligible.

Then again, men have watched the beauties of soap bubbles from time immemorial, but it was Dewar who first penetrated the secret hidden from all other men and succeeded in making them permanent by the use of pure dust-free air. It can hardly have been anything but a happy guess that led him to this: but a guess that he alone had made and verified.

Having now said something about the leaders and their work, I wish to notice the subordinates. Rayleigh's assistant, George Gordon, who was with him alike at the Cavendish Laboratory, at Terling, and at the Royal Institution, I have already noticed in my "Life of Lord Rayleigh." Heath, the lecture assistant, was civil and helpful, but not in any way outstanding.

SIR WILLIAM CROOKES, O.M., 1832–1919.

Sir William Crookes was a scientific worker typical of an epoch that has passed away. He was, I think, essentially of the school of Faraday. Like Faraday, he was of somewhat humble origin, and largely self-taught. Like Faraday, he was skilful in experimental technique, and relied mainly on his own intuition rather than on any very definite reasoning to guide him as to the subjects to be taken up; and, like Faraday, he was without the measure of mathematical training that is now expected from every serious student of physics or physical chemistry. When he was in his prime an equipment of this kind was by no means inadequate, as Crookes' own career very clearly proves; and it may be suspected that even now, too keen a critical faculty, and too much knowledge of what has been done by others, is not always an unmixed advantage to one who aspires to be a pioneer in new fields.

It was a favourite remark of Lord Kelvin that Crookes had started more absolutely new hares than any other man among his scientific contemporaries. One of the most notable, the radiometer, made its appearance at a time when scientific sensations were not so frequent as they have since become, and it excited a widespread interest. Radiometers were to be seen in the shop windows of chemists and opticians all over London, and in provincial cities as well. They were, indeed, calculated to excite the curiosity of almost anyone as they spun round vigorously in the sunlight. The chief scientific interest was aroused at first from the idea that the effect was directly due to the pressure of light, the existence of which had for long been thought probable. If this were so, the mechanical reaction of the pressure would be on the sun. When Schuster showed that the reaction was in fact on the glass bulb of the instrument much of the sensational interest evaporated. These events occurred about the time I was born; but as a boy I well remember the radiometer to be seen everywhere in the shop windows. The revolving vane was, of course, a toy, and of little use as a measuring instrument, but torsion radiometers have been developed as delicate detectors of radiant energy by E. F. Nichols and others.

It was a source of great annoyance to Crookes that he had missed the discovery of the X-rays. According to the account he gave in my hearing, he had definitely found previously unopened boxes of plates in his laboratory to be fogged for no assignable reason, and, acting, I suppose, in accordance with the usual human instinct of blaming someone else, when things go wrong, he complained to the makers, who naturally had no satisfactory explanation to offer. I believe it was only after Röntgen's discovery that he connected this with the use of highly exhausted vacuum tubes in the neighbourhood. He had, at least, less to reproach himself for than another English man of science, who, it was said, knew that high vacuum discharge tubes were apt to fog photographic plates anywhere near them, and only drew the moral that the plates should be stored elsewhere.

It would not be fair to call Crookes a secretive man; nevertheless, a certain sense of reserve was apparent to those who attempted to press him for information on scientific subjects. One well-known authority on electric discharge phenomena told me that he had given up asking Crookes questions—not because information was refused, but because he had a feeling that it was not willingly given. I remember at a later visit to his laboratory, Crookes generously showed me his unpublished investigation of uranium X, the first disintegration product of uranium, which afterwards became classical. He introduced it by saying that he had no objection to showing me a research which he had in hand. I was somewhat surprised by this turn of phrase, as it had never previously occurred to me that a scientific man could be unwilling to open his mind freely about matters like this, which had no commercial application. Crookes had done a good deal of commercial scientific work, being, indeed, dependent on it for an income, and possibly the attitude I have referred to may have been cultivated in connection with it. He was also a good deal in demand as an expert witness, and his name carried deserved weight, but, as a distinguished lawyer has told me, it was not much use to press him closely as to the logical implications of what he had said. He was an admirable experimentalist and a good man of business, but not a logician.

Shortly after the declaration of war in 1914 Crookes brought forward a method of secret night signalling which he had worked out in collaboration with his assistant, Mr. Gardiner, and which consisted in putting in or taking out a weak didymium glass from in front of a source of light. The general opacity was not enough to diminish the light appreciably, and it was not apparent to the naked eye that any change had been made, but anyone in the secret who watched with a direct vision prism could readily observe the appearance and disappearance of the most conspicuous absorption band. I never heard that any use was made of this idea in practice, and it is perhaps chiefly interesting as showing the inventiveness of a man of eighty-two years of age and his desire to do something for his country.

SIR ARTHUR SCHUSTER, 1851–1934.

I have always understood that Sir Arthur Schuster met with some initial opposition from his father in following his strong natural bent towards physical science. The father's own interests were all in the direction of finance and commerce, and he was almost as much perplexed and distressed as the traditional hen which has hatched out a duckling and finds it determined to take to the water. He came to Sir Henry Roscoe and expressed his annoyance and disappointment. But Roscoe insisted that he was making a mistake and that if he would only let his son have his own way he would soon be proud of him; and so it proved.

Schuster was one of the now fast diminishing band who derived personal inspiration from Clerk-Maxwell. He used to deplore the fact that the rising generation of physicists did not study Maxwell's great book on "Electricity and Magnetism" at first hand, but were content to derive their knowledge from secondary sources. He forgot perhaps the demands made on the student by the ever-widening range of scientific knowledge, and the necessity for learning established doctrine in whatever way may be the easiest.

I learnt from Schuster an aphorism by Maxwell which is perhaps not on record, and this opportunity of preserving it may be taken. Some question being raised as to whether a particular scientific communication was worth publishing, Maxwell remarked: "Whether it is worth publishing depends on what ratio the ingenuity it displays bears to the whole ingenuity of the author." This consideration may very naturally guide authors themselves; but referees and publication committees usually attempt to apply a more objective standard of merit.

The following from Schuster to Rayleigh (August 1st, 1909) is worth preserving:—

"There is much in these letters [from Maxwell to Rayleigh] that is interesting. If opportunity offers I think the one dated December 6th, 1871, is well worth publishing.† I don't remember the 'moral' of the 2nd law [of thermodynamics] being put in the way it is done in this letter. The description of the consequence of reversal of motion of every particle in the universe I have seen ascribed to Kelvin. It is put in this letter as something original. As regards this matter it would no doubt appear very grotesque to an outsider if he could see people imagining that they are getting older when they are really getting younger, but should *we* notice anything strange about it? If anyone was to assert at the present moment that this reversal has taken place, and that all our recollections are really prophecies, and *vice versâ*, is there anything to disprove it? Here is the foundation of a new philosophy."

Schuster's style was essentially addressed to academic readers, and even in his more popular writings, such as "Britain's Heritage of Science," he made, and desired to make, no appeal to the gallery. His enthusiasm was not obviously aroused by skilful technique or by ingenious mechanical devices. For him, science consisted mainly in the discovery of scientific facts and laws, not in applying them to the service of man. So well-balanced a mind could not fail to understand how great are the difficulties which inventors have to overcome; but these triumphs were not the things in which he personally delighted.

As Secretary of the Royal Society, Schuster always took a broad point of view about the scientific work on which it was his duty to form a provisional judgment. With his great interest in the history of science, he had taken to heart the lesson that the orthodox view is not necessarily right. Thus on one occasion when the views of the late Professor A. W. Bickerton, of Christchurch, New Zealand, on "impact" had come up, Schuster characteristically remarked: "We must give the heretics their chance." He was quite prepared to consider with an open mind the alleged phenomena generally called "spiritualistic," but modestly doubted his own capacity to detect trickery.

He thought that scientific bodies should not attempt to restrain men of established position from expressing any views they pleased. That, he considered, was outside their proper function. "If," he would say, "a man of standing chooses to make a fool of himself, that is his own affair, and I do not see that it is anyone else's business to stop him." When, late on in his life, a paper of his own was criticised by a referee, he took the view that at his age he had earned the right to say what he liked. He considered that the system of the French Academy of Sciences, which allots, as of right, a certain amount of space to each of its members, was worthy of imitation.

As a man of science, Schuster was singularly fair-minded and unprejudiced. To the end of his life he remained free from the inflexibility of opinion which is so often the penalty of old age. For example, I ventured to ask him whether he still adhered to the opinion expressed in the preface to his "Optics" (1904), "Those who believe in the possibility of a mechanical conception of the universe, and are not willing to abandon the methods which, from the time of Galileo and Newton, have uniformly and exclusively led to success, must look with the gravest concern on a growing school of scientific thought which rests content with equations representing numerical relationships between different phenomena even though no precise meaning can be attached to the symbols used." "No," he replied, "I do not see how one can stand to that any longer."

Throughout a great part of his life his health was not very firm, though so far as I know he was not put out of action by long illnesses. He remarked once to me that he found that he could give an elementary lecture better when he had a slight headache, because that removed the temptation which he otherwise felt of allowing his mind to run on to other matters.

Even in hours of relaxation the subjects on which he chiefly liked to dwell were science and the personalities and idiosyncrasies of scientific men. Politics hardly seemed to interest him at all, and he made no effort to join in when such subjects were under discussion.

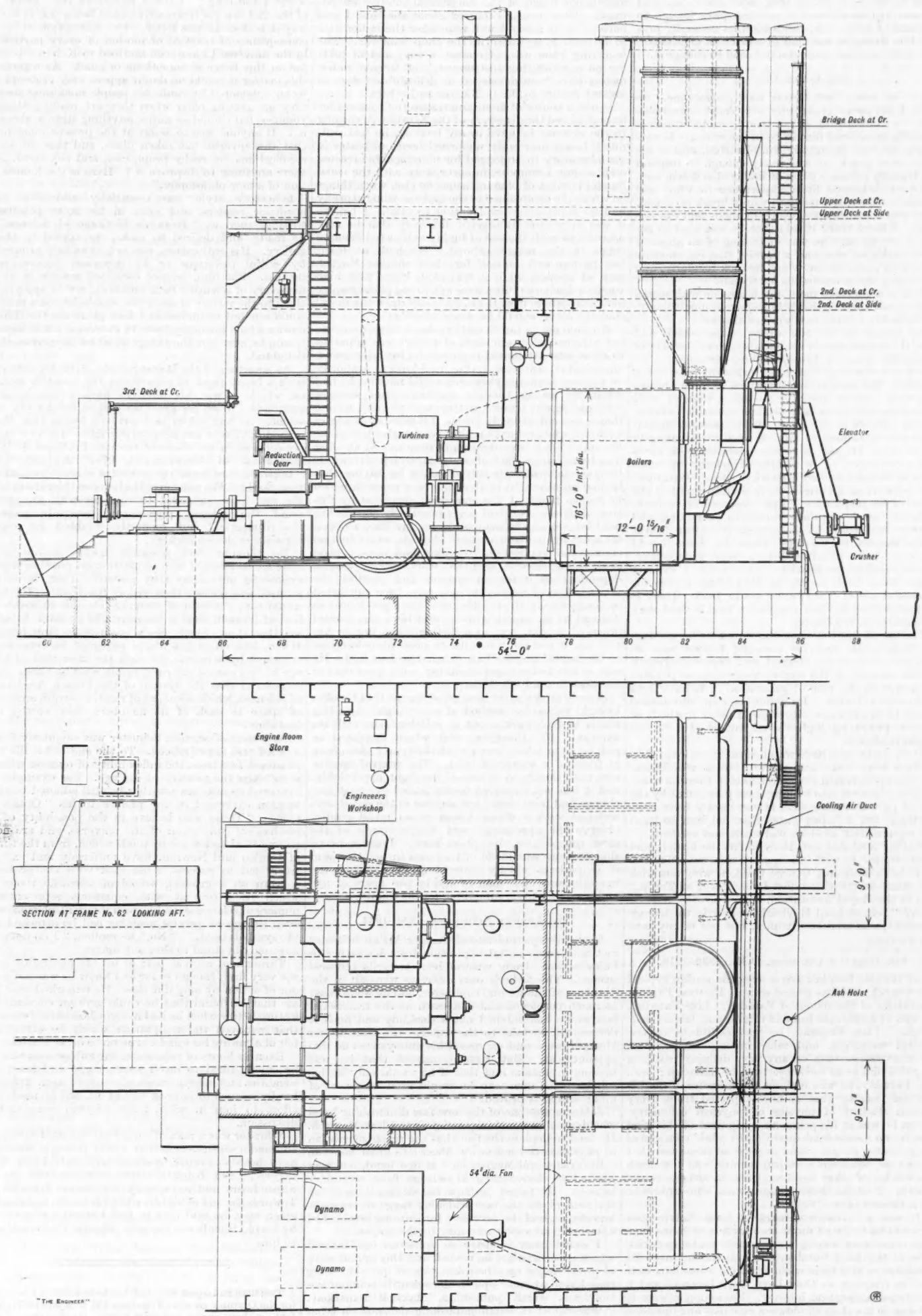
Schuster was a man of somewhat reserved exterior, and had a sensitiveness that would, perhaps, scarcely have been suspected by those who only knew him slightly. But beneath these characteristics lay a warm heart and a capacity for sincere friendship. Towards the end of his life, when his health had finally given way, he said that to find himself remembered by his old friends was the only pleasure that remained to him.

THE world's largest steel bell has been made in Germany for the Olympic games. It weighs 10½ tons and is 7ft. 6in. high, without crown and cross beam. Its diameter at the base is over 9ft. and the clapper weighs 12 cwt.

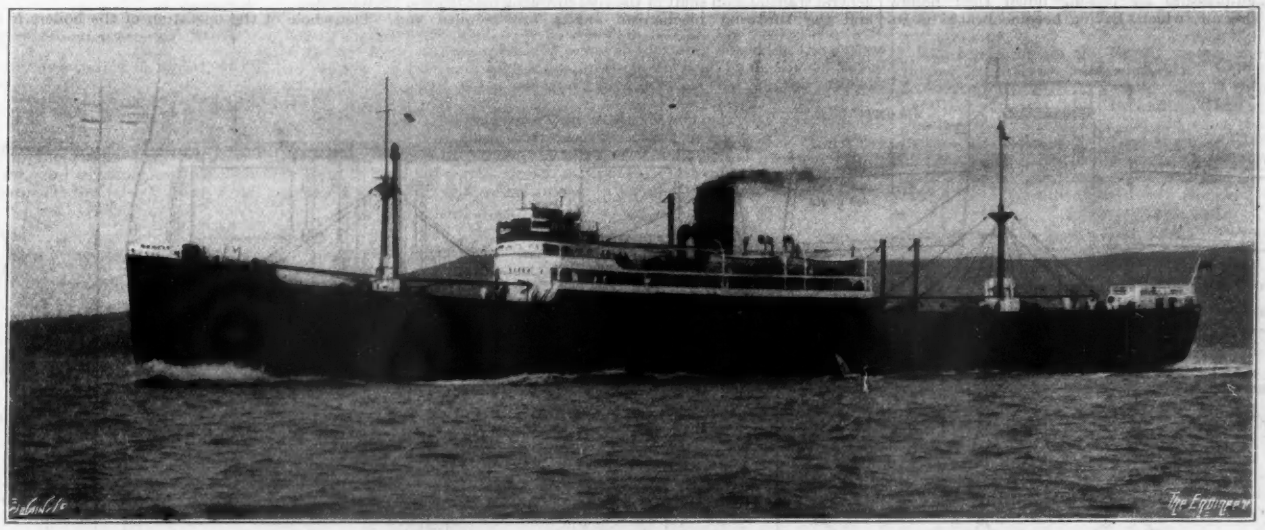
† It is now published in "Life of Lord Rayleigh," p. 47.

MACHINERY SPACE OF THE S. S. "MANCHESTER PORT"

(For description see opposite page.)



S. S. "MANCHESTER PORT" ON TRIALS OFF SKELMORLIE



Mechanical Stoking for Scotch Marine Boilers.

WE recently had the opportunity of voyaging on the trial trips of a vessel which is almost unique; we say almost because part of the novel equipment has already been tried out in a sister ship. She is the "Manchester Port," owned by Manchester Liners, Ltd., and is well represented in the engraving at the head of this page. Her peculiarity lies in the fact that she is equipped with a fully automatic system of mechanical stoking in Scotch boilers. There are, of course, several vessels in service with mechanical stokers fitted under water-tube boilers, particulars of which have been given from time to time in THE ENGINEER, but we believe that, with the exception just mentioned this is the first occasion when mechanical stoking has been applied to Scotch boilers afloat.

A little more than a year ago Mr. K. Stoker, the managing director of Manchester Liners, decided to try mechanical stoking on one of the vessels under his charge, and as the "Manchester Hero" was in port discharging and loading cargo it was decided to adapt her and she was equipped with Bennis mechanical stokers. Her structural arrangements, however, precluded the use of a fully automatic system of handling and elevating the coal, and it has to be shovelled up into the stoker hoppers by hand. The results with that vessel have, however, proved so satisfactory during the past twelve months, which have included some very rough weather in the North Atlantic, that it was decided to equip the "Manchester Port," then on the stocks on the Clyde, with a rather more elaborate plant of the same kind.

It may be well here to digress and point out that over and above the saving of the arduous labour of firing a marine boiler in a seaway, the scheme enables the ship to take bunkers in practically any port and take practically any quality of coal from run-of-mine to slack, with the assurance that a head of steam will be maintained. Anyhow, the "Manchester Hero" proved, we are informed, that the steam costs could be reduced by 22 per cent. as compared with hand firing; that two boilers instead of three would carry the load; and that all kinds of coal from washed fines containing 22 per cent. of moisture, through American dusty slack to dry slack with an ash content of 18 per cent., could be used satisfactorily.

So it was decided to equip the "Manchester Port" with Bennis plant. She is a vessel of 8505 tons deadweight, 5469 tons gross, built by the Blythswood Shipbuilding Company, Ltd., of Glasgow, and is 422·2ft. long by 56·75ft. beam and 27·1ft. deep. She is intended for the North American and Canadian trade and is specially arranged for carrying cattle, while there is an elaborate equipment of deck machinery, including twelve steam winches and derricks. Her masts are, of course, telescopic, so that they may pass under the bridges of the Manchester Ship Canal, and, for the same reason, the height of her funnel is limited, which has added to the difficulties of the combustion engineers on account of the small draught produced. She is driven by a single screw and has a normal speed of about 13½ knots.

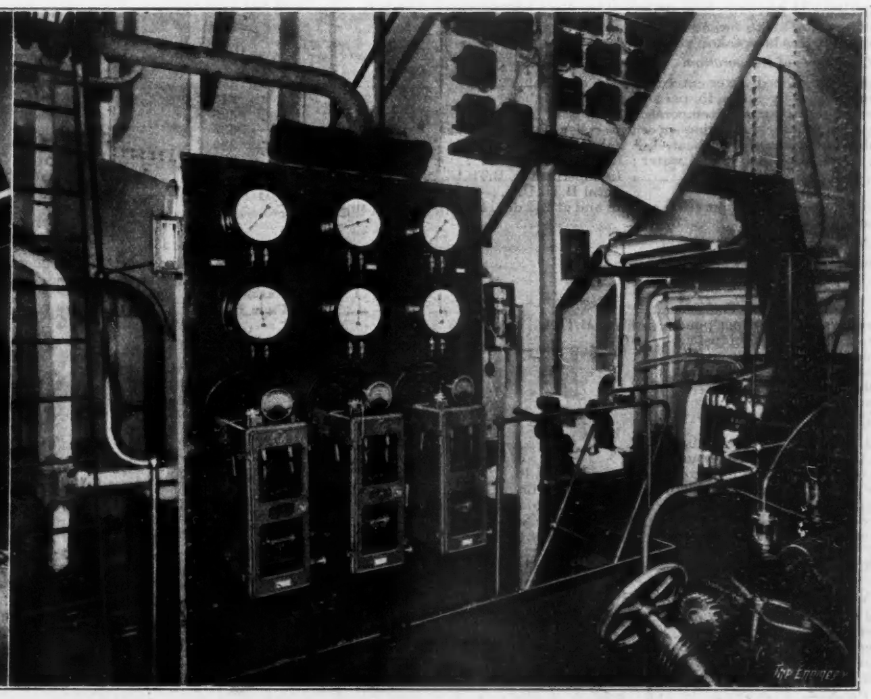
On page 156 we give a line drawing of the machinery space of the ship showing the general disposition of the various units of the plant, and we also reproduce on page 159 a photograph of the main propelling machinery, taken in the shops. It is of the Parsons single-reduction turbine type and was manufactured by David Rowan and Co., Ltd., of 231, Elliot-street, Glasgow. The working pressure is 225 lb. per square inch and there are three turbines, each driving one main gear wheel on the propeller shaft through separate pinions. The gear teeth are, of course, cut helically. For going astern there is an h.p. turbine consisting of an impulse wheel, in the same casing as the l.p. ahead turbine, which works in series with an l.p. astern turbine incorporated in the same casing as the l.p. ahead turbine. The turbines and gearings are designed for about 3800 s.h.p. at 90 r.p.m. and for a maximum power of about 4200 s.h.p.

There are three cylindrical return-tube boilers, 16ft. diameter by 12ft. long, by Rowans, each boiler having four furnaces with 8568 square feet of total heating surface each. The mechanical stoking gear was supplied by Bennis Combustion, Ltd., of Little Hulton, Bolton.

For supplying coal to the stokers there are two elevators, but only one is needed at a time. These elevators reach from recesses at the bottom of the bunker up to a transverse conveyor. Above the boot of each elevator there is a coal crusher of the Jeffrey single-roll type, made by British Jeffrey-Diamond, Ltd., of Wakefield, of which we give a line drawing. It is a simple machine and needs little explanation, the coal being dragged round against a breaker plate by a toothed roll. This machine breaks the coal down to ½in size. The transverse conveyor and the elevators can be seen at the top of one of our engravings, with the shoots leading down to the hoppers in front of the furnaces on the right. Each of these hoppers holds about 2 cwt. of coal and the conveyor will handle 25 tons an hour.

The stokers are very similar to the land type of Bennis air draught stoker, which we have described before, but have been modified somewhat for marine service. The driving shaft cannot, for instance, go straight across the front of the boiler, as in a Lancashire boiler, on account of the different levels of the furnaces in the Scotch boiler, and has to be divided into three sections connected together by skew gearing. This gearing is plainly shown in the elevation of the boiler front. The grates also are much

BENNIS MECHANICAL STOKERS



BOILER CONTROL INSTRUMENT BOARD

shorter, being only 4ft. 6in. long. It is unnecessary here to give a description of the Bennis sprinkler stoker, which distributes the coal over the grate by means of a spring-driven V-shaped shovel; but it may be as well to point out that the fire-bars are cooled by means of a draught of fairly high-pressure air passing down their hollow interiors. This air, which, having become heated in its passage, is used to help combustion, is supplied by either one of two small fans arranged in the fiddley. The forced draught fan is in the main engine-room.

The stoker mechanism is driven by totally enclosed variable-speed motors, with a reduction between the motor spindle and the input shaft of a totally enclosed worm and wheel reducing gear-box. The gear-box is provided with machine-cut gearing, with a hardened steel worm in gear with a wheel cast from Admiralty mixture bronze. The driving unit is coupled to the general transmission shaft of the coal throwing mechanism, and the throwing mechanism shafts are coupled to each other through machine-cut totally enclosed bevel gear-boxes with completely flexible couplings. The furnaces are separately driven by the same size motors and a powerful chain drive between the shafts. All the shafts are of high-tensile steel. Each motor is of the totally enclosed dust and deluge-proof variable-speed compound wound interpole type, with a variation in speed of from 750 to 1500 r.p.m. by shunt field control. All the motors were specially constructed to comply with the Board of Trade specification for sea-going and tropical conditions.

The whole of the operation of the boilers is controlled from the engine-room by means of the instrument board, of which we give an illustration. The men in the stokehold have little more to do than rake out ashes, trim coal when the bunkers get low, and oil some of the moving parts.

The boiler-room control panel is placed in the engine-room, conveniently at hand for the engineer on watch to be able to see what he is doing as he controls the stokehold with the main engines or turbines. At the top of the control board is a line of draught gauges, which give him the readings of the draughts at the various points, such as over the fires and in the uptake of each boiler.

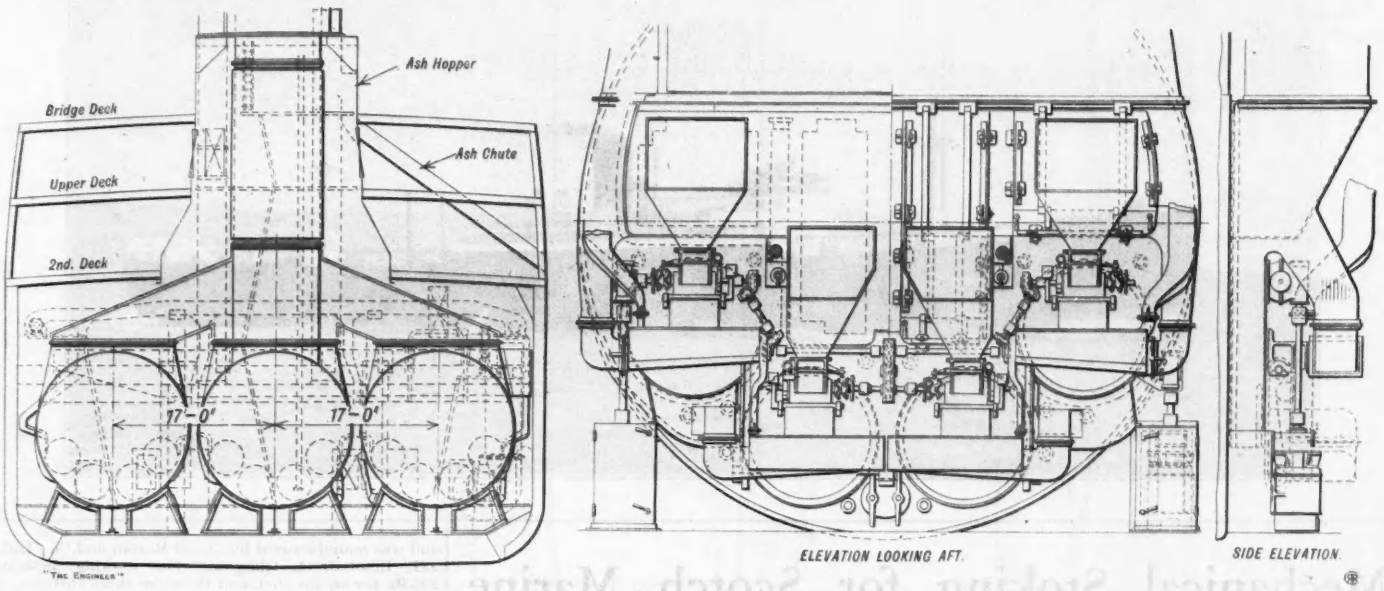
Below the draught gauges there is the electrical control. The combustion air fan, by Howden, is engine driven, is situated in the engine-room and its speed can be controlled from the turbine control platform alongside the stoker control board. Each set of four stokers on each boiler has two motors, one controlling the speed of the stokers and the other the speed of bar travel. These motors are themselves controlled by drum starting and regulating totally enclosed panels on the control board, and are each fitted with a 6in. dial ammeter marked "Port," "Centre," and "Starboard" boilers. The top three starters are labelled "Stokers" and the bottom three "Furnaces." The main damper is also controlled from the engine-room. Thus the best balanced draught conditions are easily maintained, and when manœuvring the ship the stoker may be slowed down or stopped or speeded up and the draught altered accordingly by the engineer on watch, while a sub-control is provided in the stokers themselves, except when they are entirely stopped.

The trials to which we referred at the beginning of this article took place over the Skelmorlie measured mile on the Clyde. The ship had only been out of the builder's dock a day when she went down to Tail of the Bank to adjust compasses. At half-past nine the visitors and officials went on board at Craigandoran and she immediately got under way. The run down to Skelmorlie was uneventful and then four double runs were made at progressive speeds. The first two gave speeds of 12·85 and 12·72 knots at about 80 r.p.m. The speed was then increased to 90 r.p.m. and the knots were 14·06 and 14·17. One other trip was made at 14·00 and 14·75 knots. It is noteworthy that when the ship was steaming steadily on the mile there was little more than a haze coming from the funnel, although there was some smoke when the engines were suddenly throttled down to make turns.

The coal used on these trials was slack having a calorific value of 11,312 B.Th.U. per pound as fired. Its analysis was :—

	Per cent.
Volatile matter	32·22
Fixed carbon	50·02
Ash	6·76
Moisture	11·00

The performance of the boilers may be gauged by the



CROSS-SECTION OF SHIP AND ARRANGEMENT OF BOILER FRONT

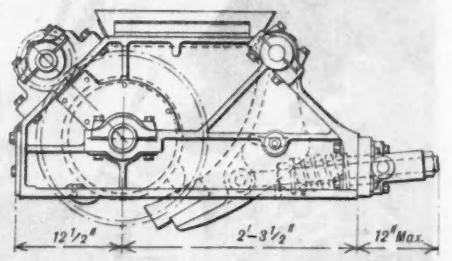
Voyage No. 1.—Manchester, Quebec, Montreal, Halifax, N.S., and Return to Manchester.

	Steaming at sea only.	Steaming at sea and under pilot and in port, banking and raising steam.
Date of test	October 11th to November 29th, 1935	
Duration of test, hours	439·87	1,160
Particulars of Boilers.		
Number of boilers in ship	Three	Three
Type of boiler	Single-ended Scotch marine, four-flued	
Size of boiler	16ft. by 12ft.	
Heating surface each boiler, square feet	2856	
Grate surface each boiler, square feet	58·5	
Ratio of heating to grate surface	48·8 : 1	
Nature of draught	Balanced	
Type of firing apparatus	Bennis system of marine stoking	
Heating surface superheater, square feet	1,140 approx.	
Conditions of Combustion (Averages).		
Temperature of flue gases, deg. Fah.	510	—
Temperature of air to furnaces, deg. Fah.	224	—
CO_2 in flue gases in uptakes, per cent.	13·7	—
Conditions of Evaporation.		
Temperature of feed water entering boiler, deg. Fah.	250	230
Steam pressure by gauge, lb. per square inch	215	200
Corresponding saturation temperature, deg. Fah.	393·8	388
Temperature of steam leaving superheater, deg. Fah.	630	600
Number of degrees of superheat, deg. Fah.	236·2	212
Heat supplied to each pound water : In boiler, B.Th.U.	990·1	1,001
In superheater, B.Th.U.	132·2	120
Total B.Th.U.	1,122·3	1,121
Factor of equivalent evaporation as from and at 212 deg. Fah. (boiler and superheater)	1·157	1·155
Nature of Fuel Used.		
Origin of fuels	Lanarkshire washed pearls, Nottingham washed singles, Nottingham washed peas, Nottingham washed slack, Canadian large coal, Sydney, Cape Breton	
Calorific value of fuel per pound, as fired, B.Th.U.	11,320	
Approximate analysis of fuel :		
Volatile matter, per cent.	31·15	
Fixed carbon, per cent.	51·00	
Ash, per cent.	5·85	
Moisture, per cent.	12·00	
Quantity of Fuel Used.		
Total weight of fuel burnt, lb.	2,262,400	3,084,480
Fuel burnt per boiler per hour, lb.	1,715	930
Fuel burnt per square foot grate surface per hour, lb.	29·35	15·87
Tons per day of coal at 11,320 B.Th.U. per lb. as fired	55·2 all purposes	
Tons per day if best Welsh at 14,500 B.Th.U. per lb. as fired	43·2 all purposes	
Coal coefficient with coal at 11,320 B.Th.U. per lb. as fired	18,432 outward, 21,546 homeward, all purposes	
Coal coefficient if best Welsh at 14,500 B.Th.U. per lb. as fired	23,600 outward, 27,600 homeward, all purposes	
Admiralty coefficient $\frac{D^{\frac{2}{3}} V^3}{i.h.p.}$	=262	—
Quantity of Water Evaporated, Actual.		
Total quantity of water evaporated, lb.	19,238,000	23,100,000
Water per boiler per hour, lb.	14,600	6,950
Water per square foot boiler heating surface per hour, lb.	5·11	2·44
Water per pound of fuel, lb.	8·50	7·50
Total heat supplied to water per pound of fuel, B.Th.U.	9,540	8,410
Efficiency.		
Total thermal efficiency boiler, superheater, and air heater, per cent.	84·1	74·5*
Steaming Conditions.		
Average displacement	10,570 tons	
Total distance steamed	5,794 miles	
Speed	13·17 knots (heavy weather experienced at times, necessitating reduced speed)	
Average s.h.p.	3,600	—
Equivalent average i.h.p.	4,200	—

Approximate Heat Balance.

	Per cent.
Heat usefully employed in superheater	9·9
Heat usefully employed in boiler	74·2
Heat lost in funnel gases	11·75
Heat lost in radiation, ash, and unaccounted for	4·15
	100·00

* Out of a total of 1160 hours for the round voyage the boilers were more or less banked for about 700 hours and were relighted more times than usual.



COAL CRUSHER

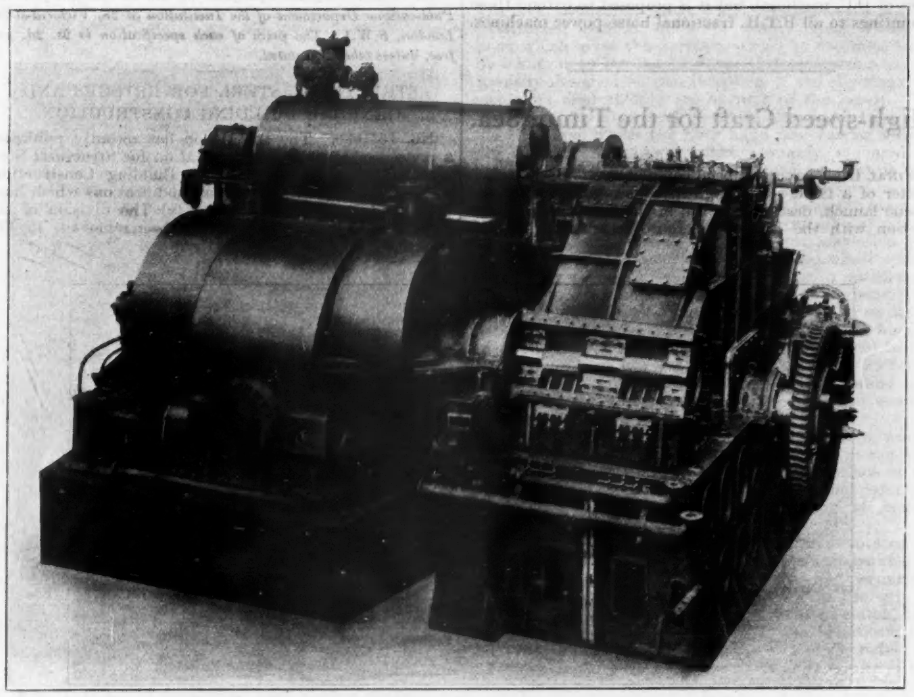
following comparative statements, which have been supplied to us :—

	Estimated operating conditions.	Actual conditions operating on voyage No. 1, Oct./Nov., 1935.
Temperature of water entering boilers	280° F. ..	239° F., rising to 250° F.
Total hourly evaporation in lb. per hour	41,000 ..	43,800
Thermal efficiency, boilers and superheaters, while steaming at sea	84 p.c. ..	84·1 p.c.

The ship then started on her first voyage, round to Manchester, and nothing happened except that we ran into a storm off the Isle of Man, which entailed a slight reduction of speed, as the ship was light. The machinery in all parts behaved admirably and gave no trouble.

We have to thank the owners, Manchester Liners, Ltd., Mr. K. Stoker, Mr. Moore, the superintendent engineer, the Blythswood Shipbuilding Company, and many others, in helping in the preparation of this article and for their hospitality.

Since we made the trip on the "Manchester Port" she has made a round voyage to Canada and back, and we append the results of the observations on the performance of the stokers which were made during that voyage as being more complete than those taken during the trial trip.



MAIN PROPELLING MACHINERY OF S.S. "MANCHESTER PORT"

THE GREAT WHINSTONE DYKE.

THE geological phenomenon known as the Great Whinstone Dyke was the subject of a paper read at Stockton-on-Tees on Wednesday, January 15th, by Mr. Albert Wilkinson, of Messrs. Cradock, Allison and Co., Ltd., quarry owners, of Eaglescliffe, at the newly formed Tees-side branch of the Newcastle-upon-Tyne and District Association of the Institution of Civil Engineers.

"The Great Whinstone Dyke," Mr. Wilkinson said, "is considered to be the most remarkable geological phenomenon in Britain. For its formation we must go back to a period in the world's history anterior to the glacial period, but subsequent to the deposition of the older sedimentary rocks when a vast break occurred in the earth's crust—a crack of such dimensions that it reached the depths where under enormous pressure a great reservoir of molten material lies imprisoned. This, set free, poured upon and filled the chasm above. This crack is supposed to be some 190 miles in length, though the average width where it reaches the surface is only a little more than the length of a cricket pitch.

"Though this huge mass of basalt—for whinstone is a basalt—is below sea level when it runs out on the East Coast, it rises to some 1700ft. above this level where it cuts the Pennine Range. By reason of its formation the Dyke has never been bottomed and has been worked through in the coal seams at a very low depth. A geologist once calculated that it went down through 3 miles of sedimentary rocks, but I question whether such a calculation is acceptable."

Describing the working of the dyke at Eaglescliffe, in County Durham, Mr. Wilkinson said: "The width of the dyke as we have worked it is from 24 to 27 yards, and at the east end we have worked to a depth of 190ft. from the surface. Our electric pumps deal with over a million gallons of water per day, so that in order to deal with our normal summer output of about 800 tons per week we are lifting over 30,000 tons of water. Unfortunately, the spring water which we pump is so hard that it is not suitable for boiler purposes and runs to waste. The specific gravity of our whinstone is 2·8, which gives a weight of about 2 tons per cubic yard in the solid, whilst the crushing strain is about 40,000 lb. per square inch."

Lloyd's Register of Shipping.

ANNUAL SUMMARY.

THE statistics issued by Lloyd's Register of Shipping of merchant vessels launched during the year 1935 show increases, both at home and notably abroad in the output of the shipbuilding industry, the total being about 335,000 tons (34·6 per cent.) greater than that for the previous year.

Particulars of Output.—Excluding ships of less than 100 tons gross, there were launched in the world 649 vessels of 1,302,080 tons gross, of which 499,011 tons were from berths in Great Britain and Ireland, and 803,069 tons abroad. The output in Great Britain and Ireland represents 38·3 per cent. of the total, as compared with 47·5 per cent. in 1934, 27·2 per cent. in 1933, 25·8 per cent. in 1932, 31·1 per cent. for 1931, and 51·2 per cent. for 1930. The outputs of the other leading countries were as follows:—Germany, 226,343 tons; Japan, 145,914 tons; Denmark, 122,095 tons; Sweden, 105,538 tons; Holland, 57,133 tons; France, 42,783 tons.

The actual increase in the world output as compared with that for 1934 amounts to 334,661 tons. In Great Britain and Ireland there has been an increase of 39,134 tons in the tonnage launched, while abroad the increase amounts to 295,527 tons. In Great Britain and Ireland, thirty-seven vessels, of 63,835 tons, were launched for owners residing abroad, equal to 12·8 per cent. of the total output. Twenty-seven of these vessels, of 52,240 tons, will be registered in the British Dominions overseas. In the principal shipbuilding countries abroad, the tonnage launched for registration under other flags was as follows:—Germany, twenty-two vessels of 96,511 tons; Denmark, fifteen of 71,109 tons; Sweden, ten of 71,316 tons; and Holland, twelve of 22,281 tons.

The world launches for the year include seventy-one vessels of over 6000 tons each, of which eighteen are of between 10,000 and 15,000 tons, and five of 15,000 tons and upwards.

The following are the largest vessels launched during 1935:—Twin-screw motor ships: "Athlone Castle," 25,500 tons; "Stirling Castle," 25,500 tons (both built in Great Britain and Ireland). Twin-screw turbine steamers: "Strathmore," 23,428 tons (built in Great Britain and Ireland); "Gneisenau," 18,160 tons (built in Germany). Twin-screw turbo-electric ship: "Potsdam," 17,528 tons (built in Germany).

The total tonnage of steamers launched in the world is 477,704 tons, of which 247,424 tons (51·8 per cent.) were launched in Great Britain and Ireland, and 230,280 tons (48·2 per cent.) in countries abroad.

The total tonnage of motor ships launched in the world is 812,956 tons. Of these, 249,605 tons (30·7 per cent.) were launched in Great Britain and Ireland, and 563,351 tons (69·3 per cent.) in countries abroad.

During the year there were launched twenty-four vessels of 181,083 tons, which are to be fitted with steam turbines. These figures include one vessel of 17,528 tons, in which turbo-electric drive is employed; in the remainder, with one exception, the turbines are associated with reduction gearing. In addition, there were launched thirty-two vessels of 70,788 tons with a combination of steam reciprocating engines and low-pressure turbines. In Great Britain and Ireland there were launched eight turbine vessels (all geared) of 61,216 tons, and nine vessels of 23,920 tons with a combination of steam reciprocating engines and low-pressure turbines.

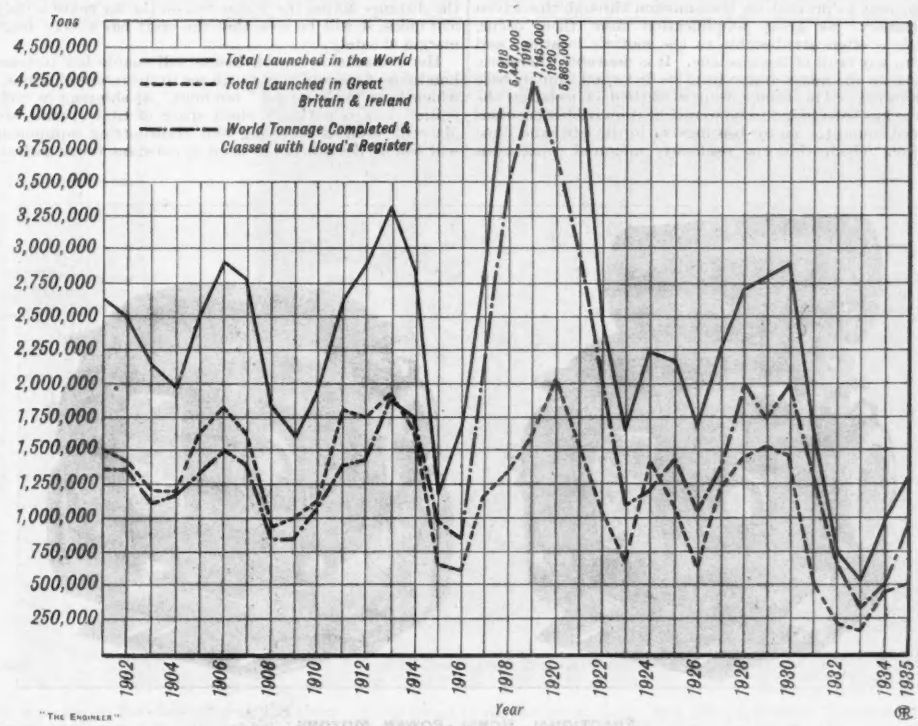
During the year forty-three steam and motor oil tankers, of 338,021 tons—excluding vessels of less than 1000 tons—were launched, of which eight, of 50,735 tons, were built in Great Britain and Ireland. Of the forty-three tankers, thirty-four, of 280,743 tons, are motor ships.

Of the steam tonnage launched in the world—477,704 tons—about 200,000 tons are steamers fitted to burn oil fuel under the boilers, so that of the world tonnage launched during 1935, approximately 21·4 per cent. is exclusively dependent on coal for propulsion.

Progress of Shipbuilding during the Year.—Lloyd's Register Quarterly Returns show that at the opening of the year 1935 the tonnage being built throughout the world was 1,251,722 tons. There was an increase at the end of March and again at the end of June. The September quarter showed a falling off of about 85,000 tons, the total then being 1,197,969 tons. At the end of December the total rose to 1,543,153 tons, showing an increase of 291,431 tons as compared with December, 1934. The figures for Great Britain and Ireland for the same dates show an increase of 146,252 tons at December, 1935.

At the beginning of 1936 four countries had more than 100,000 tons of shipping under construction, viz.:—Great Britain and Ireland, 743,086 tons; Germany, 254,121 tons; Japan, 118,610 tons; and Holland, 104,325 tons. Next in order were:—Sweden, 94,802 tons; Denmark, 61,085 tons; France, 56,078 tons; and the United States of America, 33,371 tons.

In view of the fact that the amount of tonnage laid down during 1935, as shown in Lloyd's Register Quarterly Returns, has exceeded by 299,000 tons that launched during the year, and taking into account the substantial volume of tonnage for which orders have been placed in recent months, there is evidence of a sustained renewal of activity in the shipbuilding industry throughout the world.



NEW VESSELS CLASSED BY LLOYD'S REGISTER SINCE 1901

Vessels Classed by Lloyd's Register.—Of the merchant vessels launched during 1935, 222, of 828,655 tons (143 vessels of 439,854 tons in Great Britain and Ireland and 79 of 388,801 tons abroad) were being built under the survey of the Society with a view to classification in Lloyd's Register Book.

Attention is specially drawn to the line in the diagram reproduced herewith showing the tonnage

of new vessels classed by Lloyd's Register during each calendar year for the last thirty-four years. A notable feature disclosed by these figures is that the average tonnage of new vessels classed by the Society for that long period (1901–1935) amounts to 1,541,245 tons per annum.

THE INSTITUTE OF METALS.

THE annual meeting of the Institute of Metals will be held in London on Tuesday to Thursday, March 10th to March 12th, 1936. An evening meeting will be held on Tuesday, March 10th, at the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1, at 7.30 p.m., when Dr. H. W. Brownsdon will introduce a discussion on "Metallic Wear."

The annual general meeting will be held at 10 a.m. on Wednesday, March 11th, in the Hall of the Institution of Mechanical Engineers. After the general business meeting, Mr. W. R. Barclay will present his presidential address. The following papers will be discussed:—"The Physical Properties and Annealing Characteristics of Standard Nickel-silver Alloys," by Dr. M. Cook; and "Experiments on the Electrical Resistance of Copper and some Copper Alloy Wires," by Mr. C. Blazey. The meeting will resume after luncheon at 2 p.m., when the following papers will be discussed:—"Plastic Deformation and Age Hardening of Duralumin," by Major P. L. Teed; "The Influence of Light on Electrode Potential and Corrosion Phenomena of Certain Non-ferrous Metals," by Professor C. O. Bannister and Dr. R. Rigby; and "A Deep-drawing Test for Aluminium," by Dr. A. G. C. Gwyer and Mr. P. C. Varley.

The annual dinner of the Institute will be held in the Trocadero Restaurant, Piccadilly Circus, W.1, at 7 p.m. for 7.15 p.m.

The meeting will be resumed at 10 a.m. on Thursday and the following papers will be discussed:—"The Effect of Molten Solder on some Stressed Materials," by Mr. G. Wesley Austin; "The Hot Tinning of Copper: The Attack on the Basis Metal and its Effects," by Mr. E. J. Daniels; "Influence of Surface Cuprous Oxide Inclusions on the Porosity of Hot-tinned Coatings on Copper," by Dr. W. D. Jones; "An Electrolytic Test for Zinc Coatings on Wire," by Mr. S. C. Britton. Written communications on the papers are invited.

The following visits have been arranged for Thursday afternoon:—

(1) The British Broadcasting Corporation, Broadcasting House, Langham-place, W.1, 1.30 p.m.

(2) (*a*) The Royal Observatory, Greenwich; and (*b*) The Fuel Research Station, Greenwich. Leave St. Ermin's Restaurant by coach, 1.45 p.m.

(3) Associated Newspapers, Ltd., Carmelite House, R.C.4, 2.45 p.m.

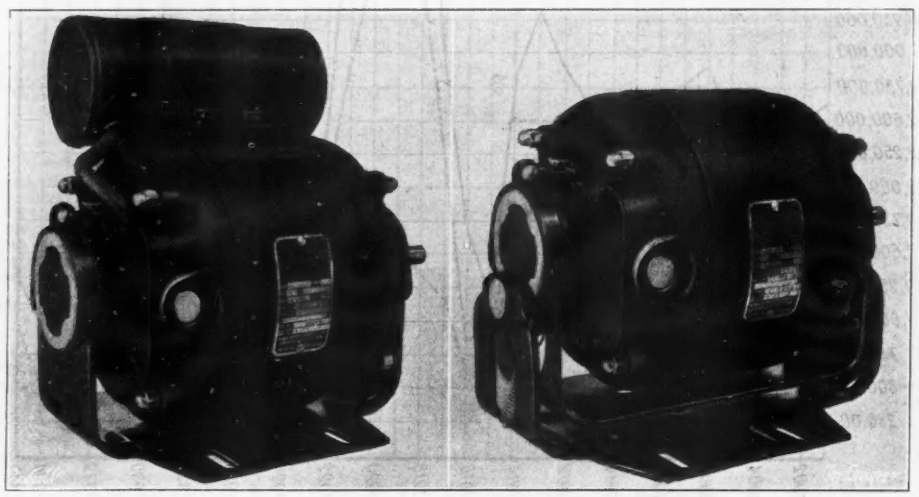
(4) *The Daily News*, Ltd., Bouverie-street, E.C.4, 3 p.m.

Fractional Horse-power Motors.

ONE of the problems that faces manufacturers of fractional horse-power motors is that of reducing noise. Since these machines nearly always work in confined spaces and are in many cases used for domestic purposes, quiet operation is essential. Since it is impossible to build a motor absolutely free from noise, it is important to prevent its transmission through the driven machinery, as great amplification may then occur. Noise is often attributable to the motor's location, and not to any fault of the machine. It is desirable, therefore, to isolate the motor frame from its drive and from its base framework. The most effective method of isolating the frame has been found to be to mount it on rubber cushions placed round the motor bearings, as in the left-hand illustration, which shows a resiliently mounted capacitator motor. The scheme holds the rubber in shear against torsional vibration and in compression against axial forces.

Another source of noise in some machines is end bumping of the rotor shaft against the bearing, often caused by minute inaccuracies in alignment of the drive. Rotor end play in the new B.T.H. motors is controlled by an indestructible steel diaphragm allied to a cushioning device. When a belt drive is used, noise is sometimes caused by incorrect belt tension, which also results in excessive wear of the belt and bearings on both the driven and driving machines. An automatic belt adjuster has therefore been introduced by the B.T.H. Company, and is shown applied to a split-phase motor in the right-hand picture. The machine, rubber mounted on an inner base, is pivoted in an outer base, and belt tension is provided by torque reaction about the outer base pivots. The result is that the belt is always just at sufficient tension to transmit the load with maximum efficiency, the belt being automatically tightened for heavy starting loads, but slackened again for the normal running load. In the normal drive the belt must be of such tension as to transmit the starting load which on such drives as compressors is sometimes in the nature of three times the normal running load. A fixed belt must therefore have sufficient tension to take the starting load, for otherwise slipping will occur during starting, with resulting belt wear.

The resilient automatic belt tension adjusters can at present be applied to all capacitator motors from ½ h.p. to 1 h.p., also on ¼ h.p. split-phase motors, and on certain sizes of D.C. machines, but it is proposed to extend these mountings to all B.T.H. fractional horse-power machines.



FRACTIONAL HORSE-POWER MOTORS

High-speed Craft for the Timor Sea.

FINAL trials have just been completed on Southampton Water of a triple-screw, high-speed, sea-going patrol and rescue launch, destined for use in the Timor Sea in connection with the Empire air route scheme. The boat has a length of 45ft., a beam of 9ft. 6in,, and a loaded draught of 2ft. 9in.

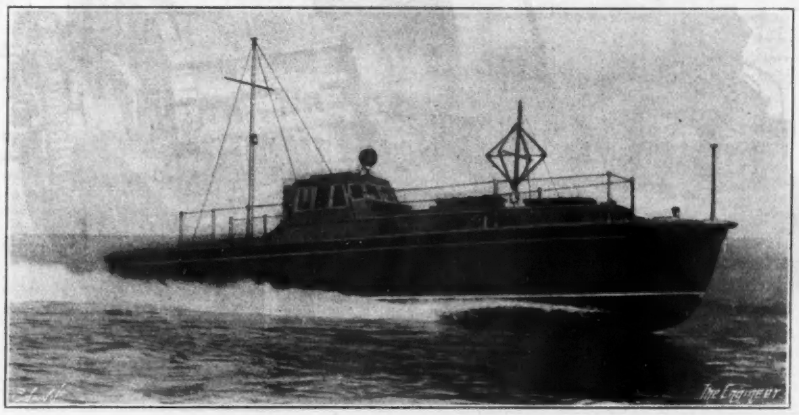
It has been designed by Mr. Hubert Scott-Paine, and built at the British Power Boat Company's factory at Hythe, Southampton.

One of the most interesting features of this high-speed craft is the fact that it has practically the largest fuel range of any high-speed motor boat in the world, and could travel from London to Stockholm without refuelling. As the distance across the Timor Sea on the air route is only 550 miles, it will be seen that the craft has a very large margin of safety.

Her remarkable seaworthiness will enable her to cross hundreds of miles of very rough sea to the rescue of aircraft which have made forced "landings," or shipping in difficulties, in a remarkably short space of time; while her Marconi wireless receiving and transmitting equipment will enable her officers to keep in constant touch with all the coastguard stations and aircraft in her area of operation. Another of her duties will be pearl fishery protection, her speed being much greater than that of any of the boats which are engaged in the illegal pursuit of poaching. She is also to be used for many other general coastal duties.

Sleeping berths are provided for five persons, whilst it would be possible to rescue and convey at high speed to the land as many as forty to fifty persons. A similar type of boat supplied by the British Power Boat Company to the British Navy has a life-saving capacity of over 100 men.

The 100 B.H.P. engines were built by Henry Meadows, Ltd., of Wolverhampton, an associate company of the builders, and they all turn in the same direction, an innovation of Mr. Scott-Paine, who claims to have thus overcome the old problem of "cast-off." Interchangeability of every component of both hull and machinery has been achieved by the special jig system, upon which all boats are built in this factory, thereby facilitating easy repairs and overhauls, which is a most important feature in craft operating so many thousands of miles from the builders' factory.



SEA-GOING PATROL AND RESCUE LAUNCH

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

STRUCTURAL STEEL FOR BRIDGES AND GENERAL BUILDING CONSTRUCTION.

No. 15/1936. The Institution has recently published a revised edition of the specification for Structural Steel for Bridges, &c., and General Building Construction. The following are the principal modifications which have been made in the new issue:—(*a*) The division of the material into A and B steel has now been removed. (*b*) The diameter or thickness of round or square bars, for purposes other than concrete reinforcement, below which tensile tests are not required to be made, has been increased from ¼in. to ⅜in. (*c*) The specified elongation for round or square bars under ⅜in. in diameter or thickness has been reduced from 20 to 16 per cent. (*d*) The specified elongation for rivet bars has been slightly increased from 25 to 26 per cent. (*e*) The number of cold bend tests has been reduced. (*f*) The rolling margin on thin plates and small bars has been increased. (*g*) The rolling margins on plates below a certain thickness and round and square bars below a certain diameter or side are now required to be ascertained separately from those of larger dimensions, the limiting figures being ¼in. in the case of plates and ⅜in. in the case of round and square bars.

CATALOGUES.

ENGLISH STEEL CORPORATION, Ltd., Vickers Works, Sheffield.—A new tool steel catalogue, No. S.S. 13/2.

GOODWIN, BARSBY AND CO., Ltd., Leicester.—A loose-leaf catalogue of road, quarry, and contractors' plant of all kinds.

CROMPTON PARKINSON, Ltd., Bush House, Aldwych, W.C.2.—A folder containing illustrations and particulars of A.C. motors.

ELECTROFLO METERS COMPANY, Ltd., Abbey-road, Park Royal, N.W.10.—A brochure describing the testing of "Electroflo" meters.

FLEMING, BIRKBY AND GOODALL, Ltd., Halifax.—A booklet giving particulars of the design and installation of a "Vee Teon" V-rope drive.

ENGLISH ELECTRIC COMPANY, Ltd., Queen's House, Kingsway, W.C.2.—Publications on fractional h.p. motors and current-limiting reactors.

CAPAC COMPANY, Ltd., 26, Brookwood-avenue, S.W.13.—A booklet on the "Bin-Aural" system and equipment for testing the internal condition of equipment.

FERGUSON, PAILIN, Ltd., Higher Openshaw, Manchester, 11.—Two humorous Christmas publications entitled "Sauce for the Goose" and "Technical Terms Illustrated."

CALLENDER'S CABLE AND CONSTRUCTION COMPANY, Ltd., Hamilton House, Victoria Embankment, E.C.4.—Booklets describing in detail the Callender-Hamilton system of unit construction bridges.

F. A. PERRY, 63, Queen Victoria-street, E.C.4.—A book issued by the firm Berliner Maschinenbau-Actien-Ges. vormals L. Schwartzkopff, entitled "One Hundred Years German Railways; Eighty-three Years Schwartzkopff."

"DEPRECIATION ALLOWANCES."—We have received a useful little book from Leopold Farmer and Sons, 46, Gresham-street, E.C.2, entitled "Depreciation Allowances on the Plant, Machinery, and Equipment of Industrial Undertakings." It contains information concerning the percentage deductions to be written off as depreciation on various classes of plant and machinery. So far as we know, there is no book of a similar nature published, and it should prove valuable to manufacturers, auditors, accountants, and secretaries for bookkeeping, costing, and income tax purposes.

Glow-Tube Clock Dials.

THE efficient illumination of the dials of large tower clocks during the hours of darkness has always presented a difficult problem, and many methods have been tried at various times. Amongst these, the use of a skeleton dial, glazed with opal glass, and illuminated by interior lamps, and the application of concentrated floodlighting, are familiar examples. Both have a fair visibility, but the real solution would seem to be the placing of the source of light on the hands and chapters themselves.

Attempts to realise this by mounting rows of filament lamps on the hands and chapters of several clocks showed very poor results, and it was not until the development

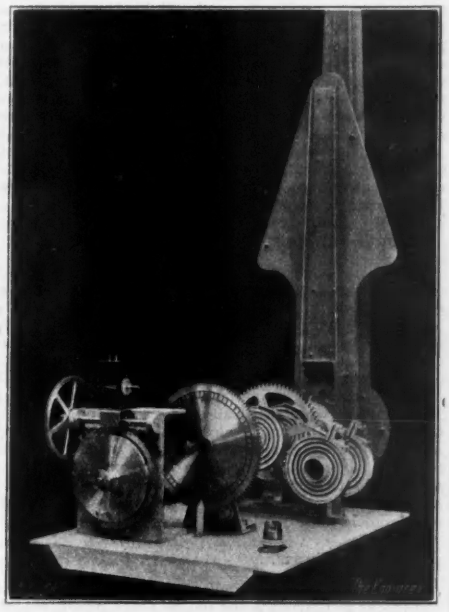


FIG. 1—DIAL MECHANISM AND GLOW-TUBE SLIP-RINGS

of glow-tubing of the type used for publicity signs that anything further was done in the matter. The glow-tubing, however, brought its own technical difficulties, for it required a high voltage for successful operation, and although the chapters of a clock dial presented no difficulty, the hands, which are in constant movement, did not lend themselves to the scheme.

The additional weight of the glow-tubing and electrodes was still another point which had to be considered, any extra load on the clock mechanism being detrimental to timekeeping.

To meet the demands of the new type of illumination, a specially designed arrangement of hands and motion work was developed, and an excellent example of this is to be seen in the new glow-tube clock installation at Stretford Town Hall, Manchester. Further interest in this clock lies in the fact that it is the first public timekeeper, apart from publicity and advertising clocks, to be illuminated by this means. Until recently only bright colours, such as red, blue, and green were available, and these were unsuitable for official clocks on public buildings. The Stretford clock is illuminated by special tubing which glows with a very pale blue tint, approximating white.

When the clock was first installed it consisted of four skeleton dials, operated by step-by-step movements and having a diameter of 6ft. 6in. The illumination was later considered, and, floodlighting proving ineffective, it was decided to adopt neon-type glow-tubing for both chapters and hands. This step involved discarding the original hands and driving mechanism, these being too light for the additional load of tubes and electrodes.

The present arrangement employs four complete units, one for each dial, each driven by an independent synchronous motor. The details of these units are shown in the reproductions of photographs and in the drawing. The dial mechanism—Figs. 1 and 2—comprises a heavily constructed motion work, or twelve-to-one reduction gear, which gives the necessary drive to the hour hand. In addition to its sturdy form, this mechanism is also specially designed for the reception of the slip rings and insulators used to feed the current to the hands. The bearing at the inner end of the minute hand tube is of the ball type, whilst the hour hand pipe carries a collar which bears upon two rollers, suitably mounted on brackets on the base plate. The turning effort is thus minimised. The synchronous motor and reduction gear which provide the drive are planted as a separate assembly at the rear of the base plate, thus allowing of easy adjustment. The motor drives through a spur reduction gear to a further worm reduction. The worm-wheel spindle of this is, in turn, provided with a spur pinion which gears with a wheel on the inner end of the minute hand pipe. By these three stages, the 200 r.p.m. of the motor is stepped down to the necessary 1 revolution per hour of the minute hand, and as a power ratio of 12,000 to 1 is obtained, the power of the small motor is amply sufficient to drive the hands and their attached neon tubing, and still provide an ample reserve to meet adverse weather conditions.

The motor is of simple construction, with a wound stator and permanently magnetised rotor. It is not self-starting. It is fitted to the planed upper surface of the casting forming the framework of the motor and reduction assembly, thus facilitating rapid changing of motors should a failure occur.

The setting of the hands is by adjustment located on the worm wheel, the thumb nut in the centre serving to lock the hand spindles to the motor drive, and permitting of manual setting when it is slackened. The grip is designed to act after the manner of a plate clutch, and any chance of slipping is obviated. It will be noticed that the setting operates through the last step of the reduction gear, and this gives a fine adjustment and permits of the heavy hands to be set easily and accurately.

The hands are of copper, stiffened by ribs at the rear, and reinforced by a casting at the centre. A somewhat unusual method of attachment to the respective spindles or "pipes" is provided. In place of the usual methods of squaring or mounting on flanges, these hands have the previously mentioned casting provided with a split collar, the internal diameter of which fits the pipes. The assembly of the hand and its pipe and the tightening of a securing bolt which draws the collar inwards slightly gives a satisfactory but easily handled fixing.

The glow-tube current is fed to slip rings mounted on circular porcelain insulators of large diameter. A groove in the rim of the insulator carries the stout bronze slip ring, the length of cable which conducts the current from the slip ring to the electrodes on the hand making direct contact with the ring. The cable has a specially high insulation value, for earth return is employed, the actual pipe through which the cable passes being part of the return connection. In the case of the minute hands, the cable passes directly from the slip ring to the hollow minute hand pipe, emerging at the centre of the hand and connecting to the glow-tube electrode. The hour hand cable is equally simple, passing through a channel in the hour pipe collar bearing, and thence by a slot in the counterbalance of the hand to the glow-tube.

This method makes short circuits and failures unlikely, and gives ease of inspection and replacement when necessary. Only one tube is used for each hand, the tubes being mounted in clips which allow of the rapid changing of a broken or defective tube.

Owing to the high voltages employed, the high-tension conductors are spaced as widely as possible from earthed objects. The sides of the slip ring insulators are provided with several circular grooves, thus increasing the length of any leakage path at this point. Somewhat similar insulators are employed to carry the brushes which make contact with the slip rings. The brushes are of springy bronze and are fitted to ring-shaped castings which are, in turn, mounted on the circular insulators for the brush gear. The ring castings are split, and a thumb nut permits of their adjustment in a rotary direction, thus adjusting the pressure of the brushes on the hands slip rings. Although very simple, this method has proved quite satisfactory.

In order to guard against the effects of condensation, and to maintain the lubricating oil in good condition in very cold weather, a carbon filament lamp is mounted on the base plate. This can be switched in when necessary, and, as each dial unit is provided with an enclosing metal cover, proves quite effective.

The voltage necessary for operation of the glow-tubing is approximately 4000, this being provided by transformers energised from the A.C. supply mains. Several transformers are used for each dial, these being fixed on the inner surfaces of the tower walls, adjacent to the dials they supply. The total electrical consumption of the four dials is 2·8 units per hour.

The blue-white glow provided by the tubing at Stretford gives a particularly efficient illumination to the dials, and the time can be read over long distances. Moreover, in misty and foggy conditions, the dials are more readable than would be possible with any form of internal or reflected lighting. The diameter of the tubing employed is 10 mm., and a line of light can be discerned in very adverse circumstances.

In addition to the four timepiece dial units, the clock also strikes the hour, a motor-driven unit—Fig. 3—being provided for this purpose. Control of this unit is by a small synchronous clock motor which revolves a let-off cam once per hour, and trips a suitable switch of the mercury type at the sixtieth minute. This, in turn, actuates a relay situated on the box bed of the striking unit and starts up the main motor. The striking hammer is lifted by a heavy snail-cam, the motor rotating this by means of a worm reduction gear and spur gears. At each blow a count-wheel is stepped one tooth, and when the correct number of blows has been struck a pin on the rim of this count-wheel automatically opens the main motor circuit, stopping the motor until it is restarted at the next hour.

Provision is also made for the addition of quarter chimes at a later date. When this occurs, the present hour bell will become the fourth quarter bell, and a new hour bell, weighing 34 cwt., will be installed. The present hour-striking unit has been designed to strike on this, and the provision of a motor-driven quarter unit will be all the additional mechanism necessary. The steelwork in the tower is already prepared for the reception of the quarter bells, and their erection will be a simple matter. Provision is made on the let-off unit for silencing the striking during the night, a twenty-four-hour wheel opening contacts included in the relay circuit connecting the let-off unit with the striking unit, and thus preventing the starting of the motor drive. This system will also be adopted for the chimes.

With the former step-by-step mechanism, the hands of the clock were operated from the master clock circuit controlling the dials throughout the building. They are now entirely separate, and form an independent time-keeper.

The clock installation has been carried out by Gillett and Johnston, Ltd., and the glow-tube illumination is the work of Boro' Electric Signs, whilst the whole was erected to the instructions of Mr. Edwin Parker, M. Inst. M. and Cy. E., A.M.I. Struct. E., the Borough Engineer and Surveyor.

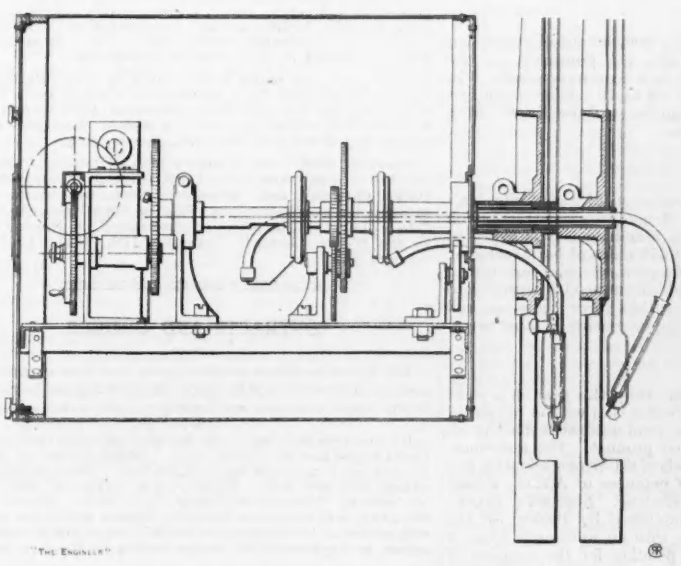


FIG. 2—ARRANGEMENT OF DIAL UNIT

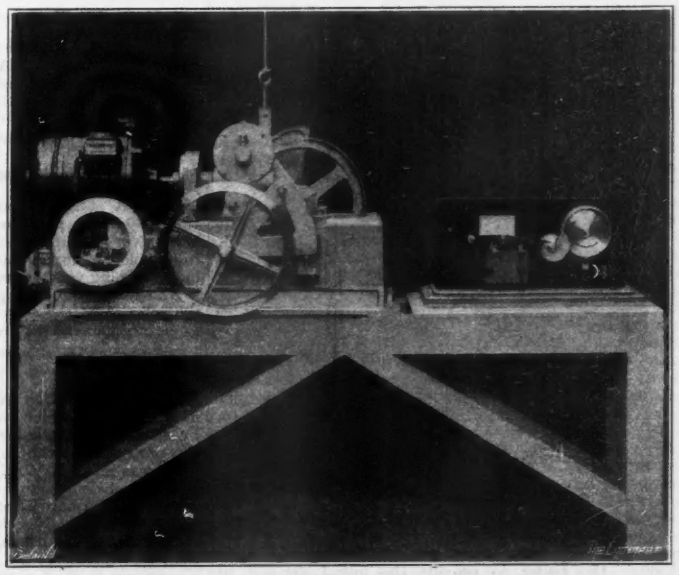
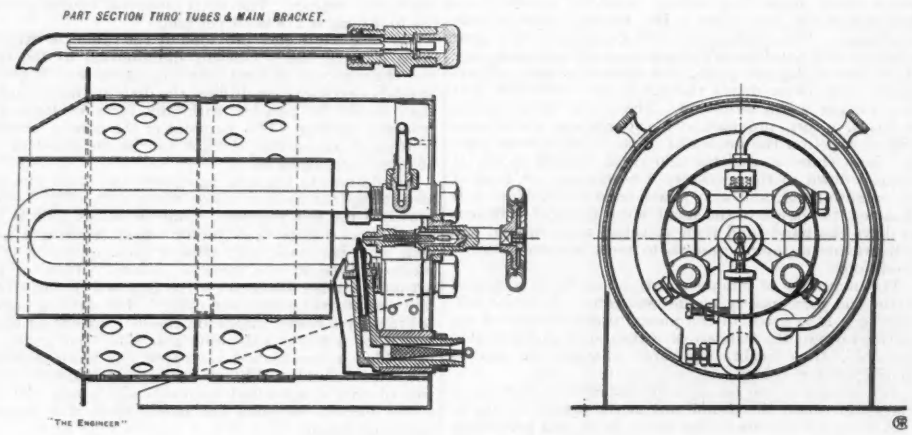


FIG. 3—MOTOR-DRIVEN HOUR STRIKING UNIT

IT has been decided by the Southampton-Isle of Wight Steam Packet Company to change the name of its 365-ton paddle steamer "Queen" to "Mauretania." This change is being made to oblige the Cunard White Star Line in order to preserve the name "Mauretania," should that company want it for another ship in the future.

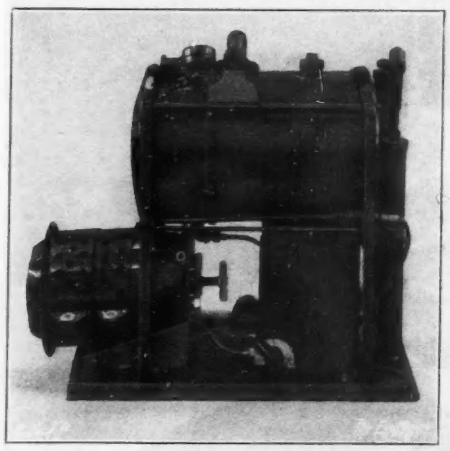
A Self-contained Oil Burner.

THE firm of Rutherford Oil Burners, Ltd., of Chandos House, Buckingham-gate, S.W.1, has for some time been manufacturing an interesting form of oil burner for use in Army field kitchens. The necessities of the work have resulted in a design which is portable, simple to operate, and is independent of outside sources of power. The burners are now available for civilian use. They are operated by steam generated in a simple flash-point boiler which consists of one or two U-shaped tubes placed in the flame of the burner and feeding steam to a horizontal jet The steam from this jet passes over a vertical fuel jet and causes the fuel to be drawn upwards and atomised. The drawing shows a section and elevation of the burner. It also shows a section of part of one tube of the boiler together with the surge-preventing core rods fitted in each leg of the boiler tubes. The rods are easily removable through the cleaning plugs provided. They, like the tubes, are made of rustless iron, guaranteed to withstand a temperature of 1000 deg. Cent., and their presence reduces the formation of scale. The filters provided in the steam line, as well as in the fuel line, will be noted. Both



ARRANGEMENT OF OIL BURNER

are easily detachable for cleaning, though the steam filter is cleaned automatically by the ejector effect which takes place when the burner is shut down and the valve shown behind the filter is opened. The complete burner with tanks, &c., is also illustrated. The water tank surrounds the fuel tank concentrically and is maintained under a pressure of about 30 lb. per square inch by means of a hand pump. The size of the flame varies in proportion to the pressure applied to the water tank, and a safety device is inherent in the design, as should a pressure be produced in the tank which is greater than the steam-raising capacity of the boiler, water will issue from the steam jet and put out the burner. To reduce the flame the tank pressure is reduced by an adjustable air vent. To increase it the pump is made use of. To light up the burner the water tank is pumped up to the necessary pressure with the three-way cock in the "Off" position. When it is turned to the "Start"



SELF-CONTAINED OIL BURNER

position air is taken from the top of the water tank through the boiler to provide the initial draught at the steam jet. The atomised fuel is then lit by means of a torch, and after one or two minutes the three-way cock is turned to the "Running" position, causing the air supply to be cut off, the boiler to be connected to the water outlet, steam to be generated, and to continue the atomisation process. The fuel jet is supplied from a float chamber, which maintains the fuel at a predetermined level. When necessary, a metering valve is also fitted between the jet and the float chamber to adjust the feed for different grades of fuel. The burners have been used for oils of widely differing viscosities. The air supply is drawn in through adjustable primary and secondary ports. Various models of the burner are available having fuel consumptions from 3 pints per hour to 2 gallons per hour.

Canadian Engineering News.

(By our Canadian Correspondent.)

New Private Dock.

BUCKERFIELDS, Ltd., Vancouver millers, have let a contract for the construction of a private dock to accommodate ocean-going vessels. The dock, which is the first major waterfront development to be undertaken by a private firm in Vancouver for a considerable time, will be 450ft. long and 110ft. wide. Actual construction will cost about 40,000 dollars, and another 20,000 dollars will be spent on modern conveyor belting equipment.

Smelting and Refining.

The very pronounced and almost general expansion realised throughout the Canadian non-ferrous smelting and refining industry in 1934 was reflected in the estimated cost of ores, concentrates, &c., treated in smelters and refineries, which totalled 78,325,552 dollars, as compared with 43,242,563 dollars in 1933; value of primary products in metallurgical plants in 1934 amounted to 149,936,239 dollars, as against 100,561,297 dollars, and the total value added through the treatment of crude or semi-crude mine materials in Canadian works totalled 71,610,687 dollars, representing an increase of almost 25 per cent. over the corresponding value of 57,318,734 dollars in 1933.

Smelter Expansion.

Construction of a 6,000,000-dollar addition to the smelters of the International Nickel Company of Canada at Copper Cliff, Ontario, has been arranged. The programme contemplated comprises the construction of an addition to the Copper Cliff smelter, served by a new high stack and the installation of two reverberatory furnaces and eight converters, with the necessary auxiliaries, such as blowers, airlines, and electrical equipment. It will take about a year to complete the work.

Absorption Plant.

The construction of a 300,000-dollar absorption plant by the British-American Oil Company, in the South Turner Valley district, has been announced. The plant will have a capacity of 60 to 70 million cubic feet of gas per day, and its supplies will be drawn from independent wells in that area.

Highway Construction.

A start has been made on British Columbia's 1,500,000-dollar programme of highway construction on Vancouver Island and on the Mainland. It is expected to complete between 250 and 275 miles of hard surfacing in the coming year, as part of a plan, which, if maintained at the same rate, will provide a surfaced highway into the interior of the province within three years, as well as giving the necessary road improvements in other areas.

Coal.

Construction will start early this year on a plant near Halifax in which Nova Scotia coal will be converted by scientific processes into a semi-anthracite having all the properties of the imported product. The announcement was made by A. E. Becker, a German scientist and formerly chairman and chief engineer of A.E.G., a subsidiary of German General Electric. Successful experiments have already been conducted by Becker for the conversion of Ontario lignite into an anthracite type of coal, and arrangements are pending for the creation of a company to develop such conversion on a large scale.

Hydro-electric Progress.

The annual review of hydro-electric progress in Canada, prepared by the Dominion Water Power and Hydrometric Bureau, discloses a substantial addition to the total developed water power capacity in the Dominion during 1935. New installations aggregating 362,080 h.p. were completed and made ready for operation, thereby bringing the total for the Dominion at the end of the year to 7,909,115 h.p. While the increase in generating capacity is noteworthy, of greater significance is the continued growth in power demand that took place during 1935. For the nine months of the year for which records have been compiled there has been a total increase of more than 11 per cent.—not confined to any one part of the Dominion, but evident from coast to coast. The new installations in 1935 comprised, chiefly, additions to existing developments such as the big Canyon plant of the Ontario Government on the Abitibi River, where the Hydro Electric Power Commission completed the installation of three additional 66,000 h.p. units, thus bringing the plant to its designed capacity of five units totalling 330,000 h.p., and the Beauharnois plant of the Beauharnois Light, Heat and Power Company on the St. Lawrence. This company, after starting its sixth 50,000 h.p. unit in December, 1934, placed in operation its seventh during the month of May, 1935, and completed in the month of September the installation of an eighth unit of the same size. The Maclaren-Quebec Power Company is adding a fourth 30,000 h.p. unit to its High Falls hydro-electric plant on the Lievre River, in the province of Quebec, to be completed in February, 1936, thus bringing the development to its total ultimate capacity of 120,000 h.p.

Mineral Output Up.

An increase of approximately 6,746,000 dollars in the value of minerals produced by Ontario mines in 1935 over the value of output in 1934 is indicated in a preliminary estimate prepared by the Ontario Department of Mines, which estimates that the 1935 production will have a total value of 152,600,000 dollars as compared with the 1934 figure of 145,854,173 dollars. Production of metals will show the major gain, the output being estimated at 135,000,000 dollars as against 129,273,033 dollars. Non-metallic production is set at 7,000,000 dollars as against 7,553,571 dollars; structural materials will have a value of approximately 9,000,000 dollars in 1935 against 7,766,563 in 1934.

Power and Paper.

The decision to proceed immediately with the completion of a water power development on the Outarde River, in the province of Quebec, and other work connected with a proposed newsprint plant in the vicinity of Manicouagan, has been made by the Ontario Paper Company, Ltd., of Thorold, Ontario. A total expenditure of 8,000,000 dollars is understood to be involved. The company owns a large tract of timber limits on the Manicouagan watershed, and also water powers on the Outarde River, held under lease from the Quebec Government. The period allowed under the terms of the lease for carrying out the work has been extended twice on account of the depression, but considerable sums have already been spent on dams, hydraulic works, and other developments.

Steam Railways.

One of the best indicators of improving economic conditions in Canada is the official Government report on steam railways. This report shows that during 1934 gross revenues of Canadian railways were greater each month than in 1933, and for the year amounted to 300,837,816 dollars, as against 270,278,276 dollars for 1933. Operating expenses increased from 233,133,108 dollars to 251,999,667 dollars, and net operating revenues from 37,145,168 dollars to 48,838,149 dollars. The tonnage of revenue freight carried increased by 10,672,480 tons, or 18·6 per cent. over the 1933 tonnage.

LAUNCHES AND TRIAL TRIPS.

FORT AMHURST, single-screw steamer: built by Blythswood Shipbuilding Company, Ltd.; to the order of Furness Red Cross Line; dimensions, 325ft. by 45ft. by 27ft. 3in.; to carry passengers and cargo. Steam engines, triple-expansion, 22in., 35in., and 63in. by 39in. stroke; constructed by David Rowan and Co., Ltd. Launched, October 16th, 1935; a speed of over 15 knots was attained on trial trip, January 29th.

ELONA, oil tank motor vessel; built by Swan, Hunter and Wigham Richardson, Ltd.; to the order of Anglo-Saxon Petroleum Company, Ltd., London; dimensions, 425ft. by 54ft. 3in. by 31ft.; to carry oil in bulk. Oil engines, Werkspoor type; constructed by builders. Trial trip, January 30th.

ZEALAND, single-screw steamer; built by Barclay, Curle and Co., Ltd.; to the order of the Leith, Hull and Hamburg Steam Packet Company, Ltd.; dimensions, 260ft. by 40ft. by 26ft.; to carry cargo and passengers. Engines, triple-expansion, 15in., 25in., 41in. by 33in. stroke; constructed by North British Engine Works. Launch, November 11th, 1935; trial trip, January 30th.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

RUSTON AND HORNSBY, Ltd., Lincoln, inform us that another Diesel engine trawler, similar to the "British Columbia," which was put into commission last year, has been ordered by the same owners, Grimsby Motor Trawlers, Ltd. The new ship is to be built by Cochrane and Sons, Ltd., Selby, Yorks. The machinery is to comprise a 350 b.h.p. Ruston propulsion engine with reverse and reduction gear, and a 75 b.h.p. Ruston auxiliary engine, with generator, to provide current for the trawl winch.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

A. M. YOUNG AND CO., engineers and machinists, Birmingham, 12, are building a new factory in Doris-road, Bordesley Green. The factory will cover an area of about 1200 square feet, and will enable the firm to employ a good many more hands than at present.

RUSTON AND HORNSBY, Ltd., Lincoln, announce that at a board meeting held on January 29th the directors elected Mr. H. B. Riggall to a seat on the board. Mr. Riggall has been connected with the company for many years, latterly in the capacity of commercial manager. Mr. T. W. Fairhurst has also been elected to the board and will assume duty as sales director. Mr. Fairhurst relinquishes his position with Crompton Parkinson, Ltd., with the assent and goodwill of that company.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

International Steel Trade Problems.

Important meetings of the Continental and British steel makers are being held in London this week, and it is understood that the co-ordinating committee of the Steel Cartel, which comprises representatives of both parties, will endeavour to settle several outstanding problems. The British are reported to have indicated to the Cartel that it is time decisions were reached on points which have been under discussion for some months. The most important of these is the method of handling the imports of Continental steel. The position is that whilst the British desire that all imports of steel should be bought by the new British Iron and Steel Corporation and distributed under its supervision, the Continental makers wish to retain their own selling organisations in this country. So far the Continent has adopted a determined attitude on this question, but it remains to be seen whether it will withstand the pressure which is being exerted by the British. The fact that this point has remained unsettled has delayed decisions upon other matters, including the arrangement of quotas for some of the export markets. Lately, great interest has been aroused by reports that quotas for Egypt and India are to be considered shortly, and some concern is expressed by merchants lest they lose the position they have held in these markets for many years. It is extremely unlikely that any attempt will be made to settle the problem presented by the thin steel sheet trade. The Anglo-Continental agreement provided that the Continental makers of this material should be formed into a comptoir which could co-operate with the British sheet makers. The number of Continental firms producing this class of material and the lack of any cohesion amongst them, however, has made this more difficult than was anticipated. At the same time, the efforts to bring about an arrangement between the Continental and British galvanised sheet makers have not been successful, partly owing to the attitude of one of the principal Belgian makers. This firm has threatened to install a tinning plant, with a capacity sufficient to provide for the tin-plate requirements of the Belgian market. It is thought the firm would be willing to modify its present intention if it were given a satisfactory quota for galvanised sheets in the export markets. Efforts by the Cartel to bring the recalcitrant Belgian manufacturer to heel have not been successful, and apparently it is receiving a certain measure of support from the Belgian Government. Discussions also took place this week on the question of a quota for British and Continental steel in the South African market. Suggestions had been made that compensation for lower imports might be found in higher prices.

The Pig Iron Market.

The settlement of the coal dispute has not been followed by any important change in the conditions which have ruled in the market for several weeks. The new level of fuel costs resulting from the advance in miners' wages has yet to be determined, and the producers show no more inclination to accept forward business now than before the coal settlement, nor have any steps been taken apparently to increase the output of pig iron. The price position has been further complicated by the result of the railway assessment appeal, which may affect the railway rates on blast-furnace materials. It is rumoured in the market that prices for all grades of pig iron will be reviewed shortly, and that until this is done little relief is to be expected by the market. On the North-East Coast the stringency is acute and practically no fresh business has been transacted for the past week or two. The make is almost entirely absorbed by deliveries against current contracts. Consumers are finding that fresh supplies are difficult to arrange and are pressing for an increase in the output of foundry sorts. It is suggested, however, that it will be necessary to ensure a larger production of coke before this can be done; but this view is not accepted by all sections of the market. Not only have the makers been obliged to refuse home business, but it is understood that any iron now being shipped is against long-standing contracts. Business in Midland irons has proceeded on normal lines. Specifications against current contracts continue to reach the makers at a satisfactory rate and deliveries have been heavy. The revival of the demand for Midland forge iron, noticed a few weeks ago, has been maintained and this is one of the most favourable features of the position. Steady conditions have ruled in the Lancashire market and there has been a considerable business transacted in the renewal of completed contracts, although few fresh orders have been placed. The situation in Scotland has become rather stringent owing to two blast-furnaces being out of commission for repairs. This leaves only six furnaces producing foundry iron. The demand for hematite shows no signs of decreasing and considerable withdrawals have had to be made from stock to meet contract obligations. Consumers would like to cover their forward commitments, but in view of the unsettled price position makers are not anxious to commit themselves to forward sales. The makers claim that they have sold the greater part of their production for the first six months of this year and can afford to mark time until the situation becomes clearer.

The North-East Coast and Yorkshire.

Practically without exception the works on the North-East Coast are operating at capacity, but lately the volume of new business has slackened. The makers, however, have sufficient orders on their books to keep them employed for months to come. The situation in the semi-finished steel department remains difficult. The works are so heavily sold forward that they are unable to take fresh orders for anything like near delivery. Recently there has been a distribution of Continental semis, but apparently the quantities received so far have not been sufficient to meet the requirements of consumers, who have been suffering from a scarcity of British material. The constructional engineers on this coast seem to be obtaining a considerable amount of fresh work, and although they have not placed much new business during the past week or so, the tonnage of orders for structural steel on the makers' books represents a good output for some months. Business in black steel sheets has considerably expanded during the past few weeks, and consumers are prepared to book further forward than the producers care to commit themselves. The motor car industry continues to provide a good outlet for this material, and there seems to be an increasing demand from the manufacturers of steel drums. Export trade with Empire countries has increased of late, but the development of business with foreign overseas markets is rather slow. In Yorkshire the markets have regained the active conditions ruling before the Christmas holidays, and business seems to be only limited by the caution exercised by producers in accepting forward business. In the Sheffield district the production of basic steel billets continues at a record rate, and even so the manufacturers are falling into arrears with deliveries. Business in acid carbon billets has been moderate, but prices have not varied from the long-standing quotations of £6 15s. for rivet forgers' quality, and £11 7s. 6d. for billets of 1·5 to 2 per cent. carbon content. The increased requirements of the aeroplane manufacturers are creating a strong demand for A.I.D. inspected steels, whilst the market for stainless steel, particularly in the form of sheets, is a feature of the situation.

Current Business.

Orders for two motor tankers have been placed with Cammell, Laird and Co., Ltd., Birkenhead, one of 9500 tons and one of 9200 tons d.w. The London and North-Eastern Railway announces that contracts have been placed recently for 160 passenger coaches which are being built under the Government-assisted loan, and 500 specially constructed wagons for the conveyance of containers, to be built under the company's normal rolling stock programme. The firms securing these contracts were the Metropolitan Cammell Carriage and Wagon Company, Saltley, Birmingham; Charles Roberts and Co., Ltd., Wakefield; the Birmingham Railway Carriage and Wagon Company, Ltd., Smethwick; and Craven's Railway Carriage and Wagon Company, Ltd., Sheffield. Other contracts: 1800 tons of steel fish-plates; 1256 pairs of carriage wheels and axles; 670 bogies for the new passenger coaches; and 4000 pairs of wagon wheels and axles. An order for a motor ship has been received by the Goole Shipbuilding and Repairing Company, Ltd. New premises will be erected in High-street, Bordesley, Birmingham, by Fisher and Ludlow, Ltd., toolmakers. The cost, including machinery for the production of press tools, jigs, and patterns, will be about £100,000. Colvilles, Ltd., have acquired the share capital of the Steel Company of Scotland, Ltd., but it is stated that the move will not cause any disturbance to the Scottish steel industry, and that no elimination of plant will take place. The annual capacity of the combined firms is about 1,500,000 tons of steel, and the present rate of output is over 1,000,000 tons. Richard Thomas and Co., Ltd., have acquired the interests of John S. Tregonning and Co., Ltd., owners of the Morfa Tinplate Works, Llanelly. These works comprise six mills. The Metal Box Company, Ltd., has acquired the tin canister section of the business of F. Robinson and Co., Ltd., of Hull. The business will be operated under the name of the Metal Box Company, Ltd., Robinson Branch. The keg and drum section will remain under the ownership of F. Robinson and Co., Ltd., and a new factory is to be constructed in which to house it. The Department of Overseas Trade announces that the following contracts are open for tender:—New Zealand, Public Works Department: Portable filter presses (Wellington, March 17th); Post and Telegraph Department: Linisher and set of cylinder hones. Egypt, Ministry of the Interior: Electrical equipment, including one 260 H.P. diesel engine coupled to one 175-kW D.C. generator; switchboard, cables, &c., in connection with extensions to the Shebin el Kom power station.

Copper and Tin.

The electrolytic copper market seems to have settled down, and if it is spared further shocks such as have been administered by the recent American Supreme Court decisions, steady conditions should rule for a time. The demand in the United States has improved, and whilst it is still principally of a hand-to-mouth description, there has been rather more forward contracting. The manufacturers of copper products are busy and could probably buy on a heavier scale than they are now doing if more confidence were felt in the general situation. Fresh talk of the devaluation of the dollar has had an upsetting effect upon the American market, but it is not believed that any steps will be taken in this direction whilst present conditions rule. Business in European countries has been spasmodic, but there has been a steady demand for rough copper from Germany in order to fill the requirements of the German refineries. Italy has been in the market for good quantities of electrolytic, and it is reported that some orders have been placed with the United States. The financial sanctions have interfered with Italian purchases in Europe, but some of the Balkan countries have taken more copper than usual. American exports of refined copper in December reached 20,609 tons, compared with 23,035 tons in November, the total exports for 1935 being 266,599 tons. In the standard market prices have had a slightly easier tendency. Speculation seems to have died down and at the moment the market appears to be waiting for a lead. . . . The tin market has developed an easier tone which may be partly accounted for by the January statistics. Mr. W. H. Gartsen's figures show that whilst the visible supply at the end of January was about 148 tons less than at the end of December, the quantities of tin in sight increased by about 2211 tons. This was largely due to the increase in the carry over in the Straits Settlements from 1023 tons at the end of December to 3265 tons at the end of January. The carry over at the Arnheim Smelter rose to 630 tons from 513 tons. Supplies and deliveries in January were nicely balanced at 9132 tons and 9280 tons respectively. It appears that the shipments from the Straits were less than expected, and the lightness of the stocks in this country accounts for the stringent and artificial conditions which rule on the London Metal Exchange. At the moment there seems little likelihood of any immediate relief, although if the tonnage in sight continues to increase the position should improve.

Lead and Spelter.

It is not surprising after the recent rapid price advance in the lead market that an easier tone should develop. It was generally considered that the upward movement had been too quick to be healthy, and that a reaction would not be long delayed. In spite of the decline in values, the undertone of the market remains sound, and consumption in this country continues on a substantial scale. Most users have covered the greater part of their requirements for a long time ahead, and are receiving regular supplies of Empire lead. Lately, however, there has been a fair amount of supplementary buying. One of the reasons for the reaction has been profit-taking by bull speculators, who entered the market when prices began to appreciate. There have been no arrivals of foreign lead in this country, most of the Mexican exports apparently going to the Continent. According to reports which have come to hand, it would seem that the outlook so far as Continental requirements are concerned is not good. The American statistics give the world's production of refined lead in December as 151,152 tons, and the total production for the whole of last year as 1,569,670 tons. The apparent consumption of lead in the United States is put at 315,500 tons, a considerable improvement upon the 298,141 tons consumed in 1934. At the same time it was less than half the average consumption for the years from 1925 to 1929. . . . For some time now the spelter market appears to have been influenced more by movements in the lead price than by any other consideration, and it is therefore not surprising that this week values developed an easier tendency. The position in this market, however, does not fundamentally change. The demand in this country is steady, but supplies are more than sufficient to meet all requirements. If the galvanising industry were to recover some of the ground which has been lost in recent years, the situation in the spelter market would entirely change. At the moment, however, there seems little likelihood of the demand from this quarter substantially improving. The speculative movement noticed recently has not been maintained, and profit taking has been partly responsible for the weaker tone. The general view is that the situation is sound, and the price cheap when compared with other non-ferrous metals.

Non-ferrous Metal Average Prices.

The course of the prices of the principal non-ferrous metals during the first month of the year was disappointing and the official average quotations for January show a decline in all departments. In the copper market the average price for cash copper dropped 7s. 10d. compared with the December quotation, whilst for three months the decline amounted to 8s. 3d. The price for electrolytic fluctuated somewhat during the month, but the net result was a fall in the average price of 11s. compared with the previous month. The average quotation for wire bars showed a drop of 11s. 5d. and the quotation for best selected copper fell 5s. 7d. The sharp price movements in the tin market resulted in a fall in the average quotation for cash metal of £10 6s. 9d. from the December figure, whilst the average for three months dropped by £8 13s. The decline in lead values was also pronounced in January. The January average quotation for shipment the current month fell £1 8s. 1d. compared with the December figure. For shipment the third following month the average was £1 6s. 5d. lower and the mean was £1 7s. 5d. down. In the case of spelter the average price for shipment during the current month declined by 12s. from the December figure, whilst the price for shipment the third following month was 11s. 2d. and the mean 11s. 8d. less. The following are the official London Metal Exchange average quotations for January:—

Standard Copper	Cash (mean)	£34	14	10¾
	3 Months (mean)	£35	2	10¾
	Settlement	£34	15	1¼
Electrolytic Copper (mean)		£39	0	3¾
Electrolytic Wire Bars		£39	4	10½
Best Selected Copper (mean)		£38	10	3¼
Standard Tin	Cash (mean)	£209	18	9
	3 Months (mean)	£201	9	0¾
	Settlement	£209	19	0
Lead	for shipment the current month	£15	7	11¼
	For shipment the third following month	£15	9	10½
	Mean	£15	8	10¾
	Settlement	£15	8	1¼
Spelter	For shipment the current month	£14	9	9
	For shipment the third following month	£14	14	4½
	Mean	£14	12	0¾
	Settlement	£14	10	1¼

Current Prices for Metals and Fuels.

Makers' official home trade prices per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. * For Markets other than Canada, India, South Africa, Australia and New Zealand 5s. per ton must be added.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. COAST—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 10 6	3 2 0
No. 1	3 11 0	3 3 6
Cleveland—	(*D/d Teesside Area*)	
No. 1	3 12 6	3 4 0
No. 3 G.M.B.	3 10 0	3 1 6
No. 4 Forge	3 9 0	3 0 6
Basic (*Less 5/- rebate*)	3 10 0	—
MIDLANDS—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 15 0	—
„ „ Forge	3 10 0	—
Basic (*Less 5/- rebate*)	3 15 0	—
Northampton—		
Foundry No. 3	3 12 6	—
Forge	3 7 6	—
Derbyshire—		
No. 3 Foundry	3 15 0	—
Forge	3 10 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 13 6	—
No. 1 Foundry, ditto	3 16 6	—
No. 3 Foundry, ditto	3 14 0	—
Basic, d/d (*Less 5/- rebate*)	3 10 0	—
N.W. COAST—	3 14 0	d/d Glasgow
Hematite Mixed Nos.	3 18 6	„ Sheffield
	4 4 6	„ Birmingham

MANUFACTURED IRON.

	Home.	Export.
LANCS.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. YORKS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
MIDLANDS—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
No. 3 quality	7 17 6	—
No. 4 „	8 10 0	—
SCOTLAND—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. COAST—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

	Home.	Export.
LONDON AND THE SOUTH—	£ s. d.	£ s. d.
Angles	8 10 0	*7 10 0
Tees	9 10 0	*8 10 0
Joists	8 17 6	*7 10 0
Channels	8 15 6	*7 15 0
Rounds, 3in. and up	9 10 0	*8 10 0
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¾in. (basis)	9 0 0	7 15 0
„ ⅞in.	9 5 0	8 0 0
„ 1in.	9 10 0	8 5 0
„ 1⅛in.	9 15 0	8 10 0
„ 1¼in.	9 10 0	9 0 0
NORTH-EAST COAST—	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	*8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
„ under 3in.	8 12 0	7 10 0
Plates, ¾in.	8 15 0	7 15 0
„ ⅞in.	9 0 0	8 0 0
„ 1in.	9 5 0	8 5 0
„ 1⅛in.	9 10 0	8 10 0
„ 1¼in.	9 5 0	9 0 0
Boiler Plates, ¾in.	9 5 0	—
MIDLANDS, AND LEEDS AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	*8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅞in.	9 2 6	8 0 0
„ 1in.	9 7 6	8 5 0
„ 1⅛in.	9 12 6	8 10 0
„ 1¼in.	9 5 0	9 0 0
Boiler Plates, ¾in.	9 7 6	7 15 0

STEEL (*continued*).

	Home.	Export.
GLASGOW AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 15 0	7 15 0
„ ⅞in.	9 0 0	8 0 0
„ 1in.	9 5 0	8 5 0
„ 1⅛in.	9 10 0	8 10 0
„ 1¼in.	9 5 0	9 0 0
Boiler Plates	9 5 0	—
SOUTH WALES AREA—	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	*8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅞in.	9 2 6	8 0 0
„ 1in.	9 7 6	8 5 0
„ 1⅛in.	9 12 6	8 10 0
„ 1¼in.	9 10 0	9 0 0

IRELAND—	BELFAST. £ s. d.	REST OF IRELAND. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¾in. (basis)	9 0 0	9 2 6
„ ⅞in.	9 5 0	9 7 6
„ 1in.	9 10 0	9 12 6
„ 1⅛in.	9 15 0	9 17 6
„ 1¼in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G. to 13-G., f.o.r.	9 15 0	9 0 0
14-G. to 20-G., d/d	11 5 0	9 10 0
21-G. to 24-G., d/d	11 10 0	9 15 0
25-G. to 27-G., d/d	12 2 6	10 7 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24

Home.	£ s. d.
4-ton lots and up	13 10 0
2-ton to 4-ton lots	13 17 6
Under 2 tons	15 10 0

Export: £12 15s. 0d., c.i.f. India.
„ £11 15s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18s. 9d.
Tin-plate Bars, d/d South Wales Works, £5 10s. 0d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 to 250 tons	5 17 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/- per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/-
„ „ 6 p.c. to 8 p.c.	£21 0 0	7/-
„ „ 8 p.c. to 10 p.c.	£21 0 0	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£33 10 0	11/-
„ „ „ 1 p.c. carbon	£36 5 0	11/-
„ „ „ 0·50 p.c. carbon	£37 5 0	12/-
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose), 76 p.c.	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/- p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/- p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, February 5th.

COPPER—		
Cash	£34 13 9 to £34 15 0	
Three months	£35 1 3 to £35 2 6	
Electrolytic	£38 17 6 to £39 2 6	
Best Selected Ingots, d/d Birmingham	£38 12 6	
Sheets, Hot Rolled	£66 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10½d.	10½d.
„ Brazed (basis)	10½d.	10½d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£32 0 0 to £33 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9½d.	9½d.
„ Brazed	11½d.	11½d.
TIN—		
Cash	£203 10 0 to £204 0 0	
Three months	£197 17 6 to £198 0 0	
LEAD	£15 10 0 to £15 11 3	
SPELTER	£14 18 9 to £15 0 0	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Grangemouth)—Navigation Unscreened	17/6 to 18/-
Hamilton Ell	20/- to 21/-
Navigation Splints	21/- to 22/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	17/- to 17/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	16/6 to 17/-
Unscreened Navigation	17/- to 17/6
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime	17/6
Secondary Steam	17/-

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	19/6 to 23/-
Furnace Coke	14/6 to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	15/6 to 16/6
„ Second	14/6 to 15/-
„ Best Small	11/- to 11/6
Unscreened	13/6 to 14/6
DURHAM—	
Best Gas	14/8
Foundry Coke	20/- to 23/-

SHEFFIELD—	Inland.	
Best Hand-picked Branch	26/- to 28/-	—
South Yorkshire Best	23/- to 25/-	—
South Yorkshire Seconds	20/- to 21/-	—
Rough Slacks	11/- to 12/-	—
Nutty Slacks	10/- to 11/-	—

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	19/6
Best Seconds	19/- to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Bunker Smalls	12/6 to 13/6
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/- to 27/6
Foundry Coke	27/- to 40/-
Furnace Coke	19/- to 22/6
Patent Fuel	21/-
SWANSEA—	
Anthracite Coals:	
Best Large	36/- to 40/-
Machine-made Cobbles	41/- to 48/6
Nuts	40/- to 48/6
Beans	25/- to 30/-
Peas	19/- to 23/-
Rubbly Culm	11/6 to 12/-
Steam Coals:	
Large Ordinary	18/- to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

French Engineering Notes.

(From our own Correspondent in Paris.)

Controlled Production.

THE idea that industrial difficulties incidental to the crisis can be overcome by limiting production to the needs of consumers governs all attempts at industrial reform, and decrees issued for that purpose have offered the fullest opportunity for putting the idea into practice, without, however, leaving much hope of controlled production being applied satisfactorily in all cases. The present law is made provisional by decree pending its passage through the Senate, and its ultimate fate will depend upon the manner in which it is found to work. By the provisions of that law, any decision to limit production adopted by three-fourths of the members of a particular industry must be accepted by the remainder, and no new works or extensions of existing works will be permitted. The State is empowered, at the request of any particular branch of industry, to take measures to ensure that a decision is adhered to by the minority, to the extent that recalcitrant makers may be compelled to close their works. In the steel trade production has only been controlled with great difficulty in circumstances that convinced all makers of the necessity of exercising strict discipline. So long as individual interests are bound up with the general interest the system of controlled production can be maintained. There have, nevertheless, been several failures which are attributed to a fear amongst small makers that an organised restriction of output will tend to create a trust of big manufacturers who will monopolise the trade.

Refuse Destruction.

The resolutions passed by the General Council of the Seine and the Municipal Council of Paris, referred to recently, in favour of removing refuse incineration stations to beyond the Paris area, must be taken more seriously than the situation appeared to warrant. No attempt has been made to minimise local complaints of air pollution by dust, and the governing bodies recognise that everything must be done to reduce the nuisance or suppress it altogether if there is to be any hope of avoiding a compulsory removal of incineration plants. The sanitary department declares that 1,200,000f. have already been spent at Issy-les-Moulineaux on devices to prevent dust from entering the chimney. The difficulty may arise from the fact that the refuse is dried in a rotating cylinder near the base of the chimney. Hot air from the furnaces is blown through the cylinder, and the dust is carried with a certain velocity to a water screen which cannot retain the whole of it. The sanitary department states that it will continue its efforts to ensure a complete elimination of dust until arrangements can be made for the removal of the plant, which, it is suggested, may only be possible in the more or less distant future. So far as concerns the Saint-Ouen incineration station, nothing can be done to improve a plant which was the first to be installed in France in 1896 and is now entirely out of date. It will have to be reconstructed. These objections to refuse destruction in the suburbs are placing serious obstacles in the way of erecting new incineration stations, which may have to be installed in outlying areas and thereby involve problems of transport that add to the cost.

Trade and Unemployment.

The official figures of unemployment continue to increase and are well on their way to half a million. They cannot be regarded as reflecting accurately the state of the labour market, because the system of relief does not provide full data of all the men out of work and there is, moreover, still a considerable number of foreigners who are unable or unwilling to leave the country. The situation is sufficiently serious to convince the Government that vigorous action is necessary to carry through existing programmes of public works and devise new means of absorbing unskilled labour. It is a question of finance. Many undertakings are held up because the State is unable to supply the promised funds. Assistance may have to be provided by a public loan, and one of 900 million francs has just been issued by the Department of the Seine for works to be continued in the Paris area. The difficulties are more serious elsewhere. There is, nevertheless, rather more activity in the mechanical engineering trades, with promise of continued improvement. Perhaps the most hopeful feature is that while employment seems assured in the Seine Department by an acceleration of undertakings now in hand, work on the Paris Exhibition will not only contribute to that activity, but may give impetus to action favouring improved trade conditions so that some general revival may coincide with its holding next year.

Underground Roadways.

The construction of underground roadways is being carried out somewhat extensively around Paris, where the circular boulevards pass under radial thoroughfares, but within the city proposals to relieve traffic congestion by means of subterranean roads have had to be rejected on account of difficulties arising out of the intricate system of sewers and mains of all kinds, complicated by the Metropolitan Railway network. Roadways cannot usually be carried below that system without passing through water-logged subsoil that would increase the cost enormously. One scheme is now under consideration for a subterranean roadway which appears to avoid these difficulties and is, moreover, regarded as offering the only solution of what threatens to be an intolerable congestion of traffic when the extension of the Central Markets is completed. It is proposed to facilitate traffic between the markets and the Place de l'Opéra by constructing a road beneath the Palais Royal and the Bourse de Commerce to the Rue de Rivoli, by a route that offers few impediments from tunnels and mains. As this scheme would relieve traffic congestion that, it is estimated, costs motor users four million francs a year in petrol alone, it is proposed to recoup some of the expenditure by imposing a small tax on cars.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

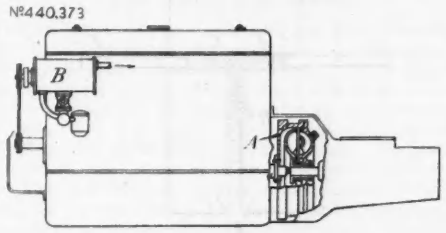
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

440,373. June 30th, 1934.—SUPERCHARGERS, The Daimler Company, Ltd., Coventry, and A. E. Berriman.

With this motor car drive an effort is made to improve the performance of the supercharger when the vehicle is moving slowly. For this reason a "fluid fly-wheel" A is inserted in the transmission gear, one of the characteristics of which is that the propeller shaft does not start to rotate until the engine is running

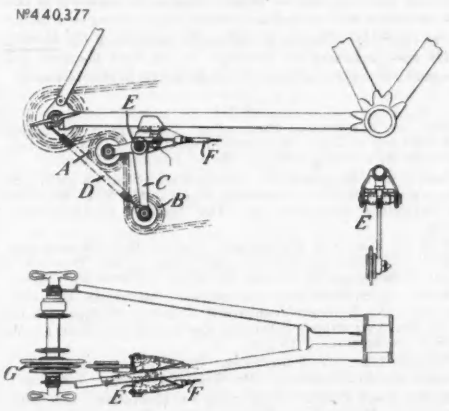


at about 850 r.p.m. The supercharger B is of the excentric blade type, and is driven directly from the crankshaft. It consequently functions from the time the engine is started and gives a more powerful supercharge when the vehicle is moving slowly than would be the case if there were a permanent mechanical connection between the crankshaft and the gear-box.—*December 30th*, 1935.

TRANSMISSION OF POWER.

440,377. July 20th, 1934.—VARIABLE-SPEED CHAIN GEARING, The Enfield Cycle Company, Ltd., Hewell-road, Redditch; and F. W. Smith.

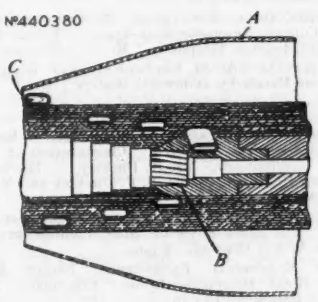
It is proposed to vary the gear ratio of a pedal cycle by moving the driving chain from one sprocket to another of different diameter on the same spindle, the slack of the chain being taken



up by jockey pulleys. The two jockey pulleys A and B are mounted on the bell crank C and tension is maintained by the spring D. The bell crank swings on the pivot E and can be slid transversely by the Bowden wire mechanism F so that either one of the sprockets G on the hub may be engaged by the chain.—*December 30th*, 1935.

440,380. July 25th, 1934.—ELECTRIC CABLES, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

In this cable advantage is taken of the fact that the insulation resistance of some materials is increased at elevated pressures. The conductors are insulated by oil-impregnated paper and are put under a pressure of from 100 lb. to 300 lb. per square inch

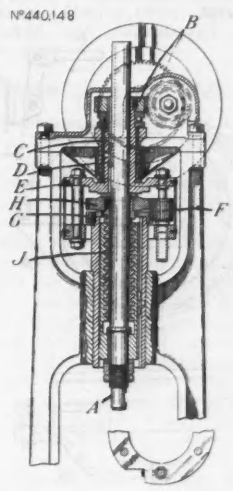


by filling the cable covering with CO_2 under such a pressure. Instead of subjecting the lead sheathing to variations in pressure caused by thermal expansion and contraction, as has been done in the past, with the result that the lead fractured, the pressure is carried by an external, hermetically sealed, steel casing A. The pressure is transmitted to the interstices of the conductor B by the helical pipe C, so that the lead sheathing is in equilibrium.—*December 30th*, 1935.

MACHINE TOOLS AND SHOP APPLIANCES.

440,148. February 5th, 1935.—FEED MECHANISM FOR BORING MACHINES, Armstrong-Siddeley Motors, Ltd., and H. R. Crowther, Park Side, Coventry.

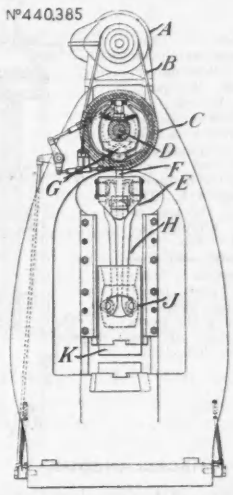
This feed gear for, for instance, a fine boring machine gives a slow forward feed, which can be accelerated or reversed by hand very simply. The spindle A is driven through the skew gearing B and the sleeve C by means of the feather key D. The sleeve C is flanged out at E to carry the planetary gear F, which engages with a sun wheel G held stationary in the framing. It also engages with another wheel H, having one tooth more, or less,



than G. This wheel is fixed to the screw J that feeds the spindle forward. The feed will be equivalent to one tooth of the gear per revolution. If a quick feed is required the planetary gear is lifted out of engagement with the sun wheel G and is itself locked on its spindle. The feed then operates at the same rate as the spindle.—*December 30th*, 1935.

440,385. August 7th, 1934.—POWER HAMMERS, B. Powell-Brett, Foleshill Works, Coventry.

This is a power-operated hammer driven by a motor A through a tex-rope B and slipping clutch C. This clutch drives the crankshaft D. The connecting-rod E comprises an upper part F,

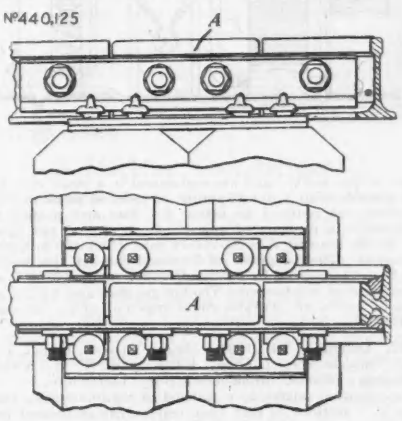


with the big-end G, and a bifurcated springy lower part H. Each of the arms of the lower part is provided with a roller J, which engages with a curved track in the tup K. In this way a resilient connection is provided and the force of the blow can be regulated by the clutch.—*December 30th*, 1935.

TRAMWAYS AND RAILWAYS.

440,125. August 14th, 1934.—RAIL JOINTS, W. Jacyna, 12 m. 6 Ul. Elsterska, Warsaw, Poland.

The inventor proposes to make the riding over the joints of railway metals more easy by inserting between the ends of adjacent rails a short bridge piece A. This bridge piece has a top surface which is curved slightly upwards. It is fixed to the rails by the fish plates and is bolted down to a tie plate on two adjacent sleepers. It is claimed that the shocks and jars to which the wheels and the rails are subjected are substantially

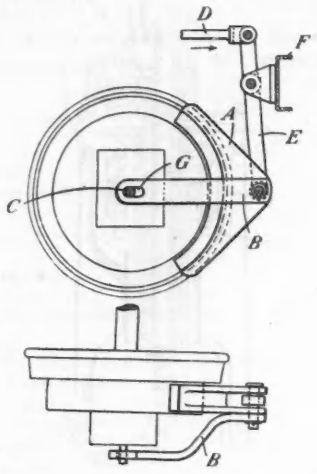


diminished, and the stresses incurred are decreased. The wear and tear of the rails and of the rolling stock are also substantially less, and the possibility of breakage or derailment minimised. Further, as a wheel rolls on to the bridge piece it encounters the rising surface of the bridge piece, so that the wheel springs are compressed and the load on the wheel as it passes on is relieved. Before the springs, however, have recovered so as to transmit the load to the wheel again, the wheel has passed from the bridge piece on to the following rail.—*December 20th*, 1935.

440,131. September 25th, 1935.—BRAKE GEAR, A. W. Simmons and the Westinghouse Brake and Saxby Signal Company, Ltd., 82, York-road, King's Cross, London, N.1.

In this brake rigging the brake block A is guided by the radial arm B, which is pivoted on a peg C concentric with the wheel

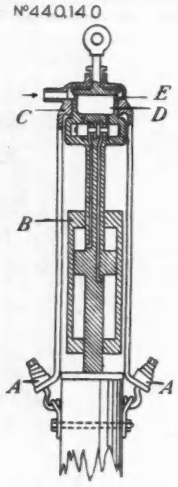
Nº440,131



axle. Braking pressure is applied by the rod D and lever E which is pivoted on the frame F of the vehicle. When the vehicle springs are depressed by loading, the brake block must follow the circumference of the brake drum, on account of the radial arm B, but it can be applied as the peg C engages in the slot G, and allows radial movement.—*December 20th*, 1935.

BUILDING.

Nº440,140



440,140. November 5th, 1934. — PILE DRIVERS AND DRAWERS, J. Wohlmeyer, 3, Ferdinand Wolfpark, Vienna XIII, Austria.

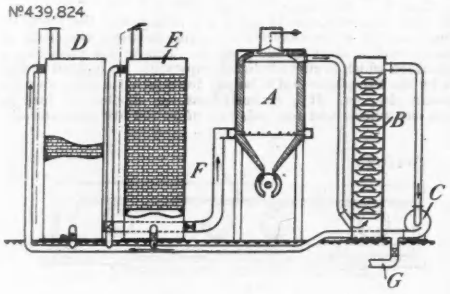
The essential feature of this pile driver or rammer is that the framing is comparatively light and is attached to the pile resiliently, as, for instance, through the springs A A. The cylinder B acts as the trip in either direction. Should the connection with the pile become dangerously loose the pressure of the steam, or compressed air, will push apart the two parts C and D of the head, and, by closing the ports E, stop the action of the hammer.—*December 20th*, 1935.

MISCELLANEOUS.

439,824. June 16th, 1934.—THE LOW-TEMPERATURE CARBONISATION OF BRIQUETTES, The Power-Gas Corporation, Ltd., Parkfield Works, Stockton-on-Tees, Durham; N. E. Rambush, "Homestead," Marton-road, Middlesbrough, and C. Ingman, 25, Del Strother-avenue, Stockton-on-Tees.

The briquettes are composed of either or both bituminous binding material and a coking coal and carbonaceous material, or materials of a low or zero caking index—for example, anthracite or coke breeze (the material being graded so as just

Nº439,824

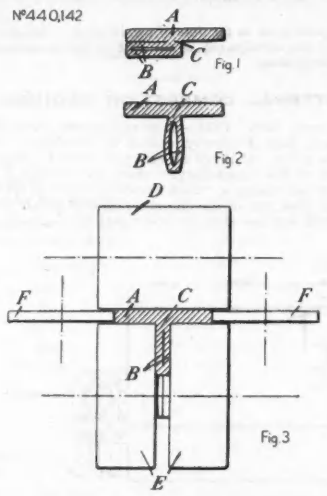


to pass a ½in. sieve)—and are carbonised in a static retort by direct contact with a hot vaporous or gaseous medium. The ingredients are reduced to below ½in. size and heated and briquetted at a pressure of approximately 2 tons per square inch. In the drawing A is the retort, into which the briquettes are charged. The gas given off is passed through the washing tower B and circulated by the fan C to the recuperators D and E, where part of it is burned. The hot gas then goes by the pipe F back to the retort. Surplus gas is drawn off at G.—*December 16th*, 1935.

440,142. December 7th, 1934.—BRAKE BLOCKS, Fibrax, Ltd., 2, Tudor-street, London, E.C.4, and N. E. Nielsen, Kingsley Works, Brook-street, Bury, Lancashire.

This invention relates to a method of manufacturing brake blocks of T section, so that they can be cut as desired from strips of woven material. The strip is manufactured in the first place by weaving asbestos (which may be reinforced by wire strands or the like) to form a main portion A having a width and thickness approximating to that of the finished block, and at the same time a hollow portion B attached only at one end to approximately the centre of the main portion as shown at C. The remainder of the appendant portion, which lies in a plane parallel to the main portion, is, however, unattached thereto. The appendant portion B can then be displaced from its initial position shown in Fig. 1 to that shown in Fig. 2, whereby it lies in a plane at right angles to the main portion A to constitute a strip of T section, the vertical limb of which, however, may be somewhat open as shown in Fig. 2. A strip of this form is then placed between the rollers D and E respectively, as shown in Fig. 3, the lower of which may be grooved to receive the appendant portion, while both rollers are movable relatively towards one another. The grooved roller is preferably split through the groove transversely of its axis, and the two parts may be adjustable to vary the width of the groove. Side rollers, F, F, rotatable about axes transverse to those of the

Nº440,142



main rollers D and E, may be employed to control the outward expansion of the main portion during the operation of rolling the T section strip to its finished shape shown in Fig. 3, where the two sides of the appendant portion have been closed and compressed together. The strip may thereafter be impregnated with some binding agent, or pieces may be cut from the strip to the desired length and then impregnated and vulcanised, the pieces, if necessary, being bent to the required curvature before vulcanising by means of a mould or by a forming tool.—*December 20th*, 1935.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF ELECTRICAL ENGINEERS: N.-EASTERN STUDENTS.—Armstrong College, Newcastle-upon-Tyne. Informal talk. "Human Side of Engineering," Mr. G. Turnbull. 7 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Education Group. Mr. F. E. Robinson will introduce discussion on "The Training of Craftsmen." 6 p.m.

INST. OF SANITARY ENGINEERS.—Caxton Hall, Westminster, S.W.1. "Difficulties Encountered Owing to the Presence of Water in Sewerage Workings," Mr. H. C. H. Shenton. 7 p.m.

INST. OF STRUCTURAL ENGINEERS: WESTERN COUNTIES BRANCH.—At Merchant Venturers' Technical College, Bristol. "The Reconstruction of Temple Meads Station, Bristol," Mr. John F. Bickerton. 7.15 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Early Windmill Gearing," Mr. Reginald Wailes. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Mining Inst., Newcastle-upon-Tyne. "Friction of Piston Rings," Engr.-Comm. C. J. Hawkes and Mr. G. F. Hardy. 6 p.m.

PHYSICAL SOC.—At Imperial College of Science and Technology, S. Kensington, S.W.7. Editing Committee meeting, 3.30 p.m.; Council meeting 4 p.m.; meeting, 4.45 for 5 p.m.

SATURDAY, FEB. 8TH.

INST. OF MARINE ENGINEERS.—85–88, The Minories, E.C.3. Junior Section dance. 7.30 to 11.15 p.m.

SALFORD TECHNICAL AND ENGINEERING ASSOC.—At Royal Technical College, Peel Park, Salford. "Stainless Steels and Other Modern Alloys," Mr. L. M. Angus-Butterworth. 7 p.m.

MONDAY, FEB. 10TH.

CHARTERED SURVEYORS' INST.—12, Great George-street, S.W.1. Meeting at 6.30 p.m.

INST. OF ELECTRICAL ENGINEERS: N.-EASTERN CENTRE.—Armstrong College, Newcastle-upon-Tyne. "Recent Developments in Long-distance Telephony," Mr. A. C. Timmis. 7 p.m.

INST. OF METALS.—At 39, Elmbank-crescent, Glasgow, C.2. "Corrosion of Metals by Industrial Waters," Mr. F. Hudson. 7.50 p.m.

TUESDAY, FEB. 11TH.

ILLUMINATING ENGINEERING SOC.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Classification of Symmetrical Light Distributions," Mr. H. Buckley; "Thermal Tests for Illuminating Glassware," Mr. S. F. Dunkley and Mr. W. R. Stevens. 6.30 for 7 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Discussion, "The River Foyle Crossing (Londonderry Waterworks)," Mr. Walter Criswell. 6 p.m.

INST. OF ELECTRICAL ENGINEERS: NORTH MIDLAND STUDENTS.—Hotel Metropole, Leeds. Chairman's Address, Colonel H. C. Fraser. 7.15 p.m.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—At Royal Technical College, Glasgow. Faraday Lecture. "Television: An Outline." Dr. E. Mallett, 8 p.m.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Modern Marine Auxiliary Plant," Mr. H. Hillier. 7.30 p.m.

INST. OF MARINE ENGINEERS.—85–88, The Minories, E.C.3. "Notes on the Turbo-electric Propulsion Equipment of the Liner 'Normandie,'" Monsieur E. Roth. 6 p.m.

INST. OF METALS: N.-EAST COAST LOCAL SECTION.—At Armstrong College, Newcastle-upon-Tyne. "Some Recent Developments in Improvement of Non-ferrous Alloys by Heat Treatment," Mr. W. T. Griffiths. 7.30 p.m.

INST. OF METALS: SWANSEA LOCAL SECTION.—Y.M.C.A., Swansea. "Some Modern Developments in Stainless Steel," Mr. J. H. G. Monypenny. 6.30 p.m.

INST. OF STRUCTURAL ENGINEERS: S. WALES AND MONMOUTHSHIRE BRANCH.—Baltic Lounge, Swansea. "Cinema Theatres," Mr. A. G. Thompson. 7 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W.1. "Atomic Arrangement in Alloys," Professor W. L. Bragg. 5.15 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. "Embrittlement of Steels," Professor F. C. Lea. 7.30 p.m.

WEDNESDAY, FEB. 12TH.

BRITISH CAST IRON RESEARCH ASSOC.—James Watt Memorial Inst., Birmingham. "The Phase Rule Applied to Metals and Alloys," Major F. A. Freeth, F.R.S. 2.30 p.m.

INST. OF ENGINEERS-IN-CHARGE.—St. Bride Inst., Bride-lane, E.C.4. "The Cause and Prevention of Industrial Accidents," Mr. James Ranger. 7.30 p.m.

INST. OF MECHANICAL ENGINEERS: YORKSHIRE BRANCH.—Mappin Hall, University, Sheffield. Thomas Hawksley Lecture. "Muscles and Nerves: The Maintenance of Posture, the Development of Power, and the Transmission of Messages in the Body," Professor A. V. Hill. 7.45 p.m.

INST. OF STRUCTURAL ENGINEERS: LANCASHIRE AND CHESHIRE BRANCH.—College of Technology, Manchester. "City Housing," Mr. R. A. H. Livett. 7 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—Bolbec Hall, Newcastle-upon-Tyne. Graduate meeting. "Mechanical Design of Commutators," Mr. W. H. D. Cookson. 7.15 p.m.

THURSDAY, FEB. 13TH.

INST. OF AUTOMOBILE ENGINEERS.—At Merchant Venturers' Technical College, Bristol. "The Development Testing of Motor Cars," Mr. C. M. Simpson. 7 p.m.

INST. OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCN.—James Watt Memorial Inst., Birmingham. "Design and Erection of Multiple Circuit Transmission Line at Stourport Power Station," Mr. H. M. Bostandjis. 6 p.m.

INST. OF ELECTRICAL ENGINEERS.—At Grosvenor House, W.1. Annual dinner.

INST. OF FUEL.—At Chemical Soc., Burlington House, W.1. "Co-ordination of Fuel and Power Supplies of Great Britain," Mr. O. W. Roskill. 6 p.m.

INST. OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, S.W.1. "The San Francisco Bay Bridge," Prof. J. Husband. 6.30 p.m.

FRIDAY, FEB. 14TH.

CHEMICAL ENGINEERING GROUP.—At the Rooms of the Chemical Soc., Burlington House, Piccadilly, W.1. "Some Aspects of Chemical Works Pumping and Acid Handling," Mr. E. A. Reavell. 8 p.m.

INST. OF ELECTRICAL ENGINEERS.—At Grosvenor House, W.1. Annual ball.

INST. OF FUEL.—At British Industries House, Marble Arch, W.1. Informal meeting. "The Economic and National Aspects of the Production of Oil from Coal." Professor W. A. Bone, F.R.S., will open discussion. 6.30 for 7 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Informal meeting. "The Mechanics of Gliding," Mr. Robert Kronfeld. 7 p.m.

INST. OF METALS: SHEFFIELD LOCAL SECTION.—At the University, St. George's-square, Sheffield. "Rose Engine-Turning and Enamelling," Mr. R. S. Hill. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1 "Mechanical Farming," Mr. D. R. Bomford. 7.30 p.m.

SATURDAY, FEB. 15TH.

INST. OF CIVIL ENGINEERS.—Students' afternoon visit to Beckton gasworks.

MONDAY, FEB. 17TH.

INST. OF STRUCTURAL ENGINEERS: MIDLAND COUNTIES BRANCH.—James Watt Memorial Inst., Birmingham. "The Influence of Direct Labour on Design and Construction of Small Highway Bridges," Mr. C. O. L. Gibbons. 6.30 p.m.

TUESDAY, FEB. 18TH.

INST. OF AUTOMOBILE ENGINEERS.—At Cavendish Café, Cornmarket, Derby. "Torsional Vibration in Automobile Engine Crankshafts," Dr. W. Ker Wilson. 7.30 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. "A General Comparison of Gas and Electricity for Heat Production," Mr. A. H. Barker. 6 p.m.

INST. OF ELECTRICAL ENGINEERS.—Hotel Metropole, Leeds. "Applications of the Hot Cathode Grid-controlled Rectifier or Thyratron," Mr. A. L. Whiteley. 7 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. "Pig Iron and its Influence on Properties of Castings," Mr. R. C. Tucker. 7.30 p.m.

WOLVERHAMPTON AND DISTRICT ENGINEERING SOC.—At Wolverhampton Technical College, St. Peter's-square, Wolverhampton. Lecture on s.s. "Normandie," Monsieur A. P. de Malglaive. 7.30 p.m.

WEDNESDAY, FEB. 19TH.

INST. OF AUTOMOBILE ENGINEERS.—Hotel Metropole, Leeds. "Needle Roller Bearings," Mr. C. H. Smith. 7.15 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Informal meeting. Discussion, "Various Advantages of Dock Gates, Caissons, and Falling Doors for Lock Entrances and Dry Docks," introduced by Mr. E. J. Buckton. 6 p.m.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND CENTRE.—Central Technical College, Suffolk-street, Birmingham. Faraday Lecture. "Television: An Outline," Dr. E. Mallett. 6.30 for 7 p.m.

INST. OF STRUCTURAL ENGINEERS: SCOTTISH BRANCH.—129, Bath-street, Glasgow. "Economical Cinema Design," Mr. J. Fairweather. 7.15 p.m.

THURSDAY, FEB. 20TH.

INST. OF FUEL: EAST MIDLANDS SECTION.—Joint meeting with Inst. of Mechanical Engineers. University College, Nottingham. "High-speed Diesel Engines," Major Goddard. 7 p.m.

INST. OF MARINE ENGINEERS.—85–88, The Minories, E.C.3. Junior Section. Film display. 7 p.m.

INST. OF PRODUCTION ENGINEERS: GLASGOW SECTION.—At 39, Elmbank-crescent, Glasgow. "Engineering Conditions in Russia," Mr. A. Monkhouse.

INST. OF STRUCTURAL ENGINEERS: YORKSHIRE BRANCH.—Hotel Metropole, Leeds. "Reinforced Concrete Structures for Retention of Water and other Fluids," Mr. W. Hunter Rose. 7.30 p.m.

RAILWAY CLUB.—At Royal Scottish Corporation Hall, Fetter-lane, E.C.4. Annual general meeting. Presidential address, "British Railways in 1845," Mr. Kenneth Brown. 7.30 p.m.

FRIDAY, FEB. 21ST.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Annual general meeting. Dr. H. J. Gough will present First Report of the Pipe Flanges Research Committee. 5.30 p.m.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—James Watt Memorial Inst., Birmingham. Discussion, "Fabrication of Metal Structures." 7 p.m.

A Seven-Day Journal

The L.C.C. and Thames Flood Protection.

AT a recent meeting of the London County Council, Mr. E. Cruse, the Chairman of the Fire Brigade and Main Drainage Committee, replied to questions raised by Lord Macmillan in *The Times*, with regard to flood dangers at Millbank reach. He said that the work of raising to the new standard levels and strengthening the flood defences of the Thames (but not of the Lee) within the County of London was now almost completed. At Millbank the work was finished in September, 1928. The new standard levels were fixed by the Council, acting on the recommendation of the then Chief Engineer, Sir George Humphreys, and the late Sir Frederick Palmer. They were constructed to withstand a tide somewhat higher even than the exceptional tide of January 6th–7th, 1928. The high tide of January 11th this year, which gave rise to the recent correspondence in the Press, did not reach the top of the defences by about 3ft. In fact, between 1928 and the present time four tides reached a higher level at London Bridge. The cracks in the concrete backing of the parapet along Millbank and the slight leakage of water that had taken place through them had been the subject of careful consideration. They were of a minor nature and appeared to be due to temperature changes in the long length of wall. They were not such as would allow flooding, and were not a symptom of any deep defect in the embankment wall itself.

Underground Railway Traffic.

ON Sunday, February 9th, the London Passenger Transport Board began the huge task of specially examining and subsequently sorting and counting all the tickets used on the Underground Railways during the seven days, February 9th to 15th inclusive. The analysis of the information to be obtained is regarded as being essential to the efficient working of the railways, providing as it does particulars of the density of traffic over each section of line and at the interchange stations. One of the purposes for which the results will be employed will be the study of the interchange facilities. When the week has ended the traffic audit branch will have in its possession 7,500,000 railway tickets. These tickets will be sorted to ascertain not only the number of tickets used between each pair of stations, but also the routes travelled as indicated by the clipping at each interchange station. For this purpose the shape of the clipping is varied at different stations. Information received concerning season tickets also will be taken into account. The sorting and counting of these tickets will occupy a staff of forty for 7½ months. The tickets will have to be divided into 50,000 pairs of stations, and 1174 interchange routes. In the course of the work the staff will make 2,500,000 entries on collection and analysis sheets, and 600,000 calculations. Finally, the traffic audit branch will prepare immense statements showing the journeys made by the millions of passengers who travel during the week.

Atlantic Liner Rating Agreement.

DURING the past few weeks there have been considerable differences between British and other shipowners with regard to the rating of Atlantic liners. At a meeting of the Atlantic Conference, held in Paris from February 6th to 8th, under the chairmanship of Mr. H. G. Dring, however, all matters of difference were reviewed and complete agreement arrived at. The situation created by the adoption of the cabin designation for top class in certain ships has been solved by the abolition of the first-class designation. Ships hitherto called first-class will be known in future as cabin ships. In addition to a revised schedule of rates, various minor adjustments have been agreed to. They will be announced by the lines concerned. The effective date for rate changes will be February 24th. It is understood that, in the new classification, ships of the United States lines will come about the middle of the scale. In the second class of the categories in which "cabin ships" are to be listed will be the "Bremen" and the "Europa." After these will follow, in different categories, the "Empress of Britain," the "Manhattan," the "Georgic," and the "Lafayette." Other vessels will be classed according to age, speed, and size. The "Queen Mary" and the "Normandie" are in the top class. The new classification will probably have its effect on the future design of Atlantic liners.

British Ports.

IN an address before the Institute of Transport on Monday last, February 10th, Sir David Owen, General Manager of the Port of London Authority, referred to the danger of excessive capital expenditure on the development of the harbours of Great Britain, of competition between different centres, and of the need for grouping British ports for control purposes. He pointed out that the total capital expenditure at all the ports of the United Kingdom exceeded £230,000,000, and that unless the overseas trade of this country were likely to increase in the future, in the same ratio as it had done during the past century, then the question of the development of ports would need to be carefully watched to ensure that capital was not wasted in duplication, or that the port capacity was not allowed to exceed the requirements of the trade. He pointed out that with the modern tendency for ships to increase in size, the number of ports capable of accommodating ocean-going vessels must decrease unless large sums were spent on development. He suggested the alternative that ships should call at one port only, discharging all their cargo, to be distributed by coastal ships and by rail and road. Such an arrangement might prove more economical and efficient. In conclusion, Sir David said that eventually grouping must be faced, and that the country could be divided into districts commercially and geographically interested in certain port facilities. The interests of the community would then be the provision of adequate port service for the whole district.

The Naval Conference.

THE first meeting of the Drafting Sub-Committee of the Naval Conference was held on Wednesday, February 12th. Its instructions are to draft clauses of the treaty which embody those agreements which have so far been reached with regard to limitations of size, both of ships and of guns, and which shall be applicable to each category of war vessel. The points on which the Conference is in agreement so far are understood to cover only the lesser categories already defined by the Second Technical Sub-Committee, as reported in a Journal note of February 7th. The limitations to be applied to capital ships are still under discussion; they have not yet been made public, but are understood to differ in some particulars from those made in earlier treaties. Since quantitative limitation has now been abandoned as a basis, the Drafting Sub-Committee has to deal only with "A" class cruisers, in which a "building holiday" for the duration of the Treaty is understood to have been accepted; with "B" class cruisers, for which a size limit in the neighbourhood of 7500 to 8000 tons has been accepted; with submarines, for which limits have been agreed on in the neighbourhood of 2000 tons and 5·1in. guns; as well as with such small vessels as were exempt from the limits imposed by the London Treaty.

The Late Lt.-Col. Sir Bradford Leslie.

RAILWAY and civil engineers will learn with regret of the death, at the age of seventy years, of Lieut.-Col. Sir Bradford Leslie, at Auckland, New Zealand, on Wednesday, February 5th. He was the only son of the late Sir Bradford Leslie, the great builder of bridges, and after leaving Marlborough went to India, and served with his father on the construction of the Jubilee Bridge over the Hooghly at Naihati. A few years later he was appointed to the Bengal-Nagpur Railway and was associated with the construction of some of the larger bridges on that line. Later he became deputy agent and chief engineer to Sir Trevredyn Wynne. When he returned from India he worked for some years under Sir John Wolfe Barry as a consulting engineer in Westminster and specialised in the design of locomotives and rolling stock for India. For some time before the war he held an important position with Vickers, Ltd., and travelled widely in the interests of that firm. He obtained a commission in the Royal Engineers in 1917 and did valuable work in France, where he remained for some time after the war on salvage and disposal work. After a short time with the Ministry of Transport he was chosen to succeed Sir Francis Spring as chairman and chief engineer of the Madras Harbour Board.

Compensation to Workmen.

IN a Home Office White Paper an approximate estimate of the total cost to industry of workmen's compensation in 1934 is given as something under £11,000,000. Detailed information is taken from seven groups of industries—shipping, factories, railways, docks, mines, quarries, and constructional work. The total cost of compensation paid to workmen is estimated at over £7,000,000. The collective returns cover 139,482 employers and accounted for 77·3 per cent. of the cases compensated. The compensation paid in the seven industries was £5,774,538, of which 38·4 per cent., or £2,215,281, was paid by mutual indemnity associations in the capacity of insurers; 21·9 per cent., or £1,265,206, was paid by insurance companies, and 39·7 per cent., or £2,294,051, was paid by employers either directly or through mutual indemnity associations; in respect of liabilities not covered by insurance, £658,732 was paid in respect of 2229 fatal accidents, and £5,774,538 in respect of 401,459 non-fatal accidents. Compensation paid in fatal cases amounted to 11·4 per cent. of the total amount paid in compensation. In the shipping group the percentage was 27·9, in factories 8·6, in docks 9·2, in mines 10·4, in quarries 17·5, in constructional work 10·6, and in the railway group 29·9. The amount paid per person employed in each group was: Shipping, 31s. 2d.; factories, 7s. 10d.; docks, 48s. 11d.; mines, 67s. 10d.; quarries, 27s. 10d.; constructional work 22s. 6d., and railways, 11s. 6d. The figure for all seven industries was 16s. 5d. There were 382,966 cases of disablement from accident, 331,029 being new cases; 18,493 cases of disease disablement occurred. Cases of dermatitis causing disablement increased from 270 in 1919 to 2566 in 1934. Compensation for silicosis and asbestosis are payable under separate schemes. During 1934, 1560 cases of these diseases occurred, and compensation amounting to £122,198 was paid.

New Director of Army Mechanisation.

THE War Office announces that Colonel A. E. Davidson, D.S.O., aide-de-camp to the King, has been appointed Director of Mechanisation, War Office, with effect from June 29th next, in succession to Major-General A. Brough, D.S.O. Colonel Davidson, who was appointed aide-de-camp to King George in 1935, is one of the senior colonels in the Army drawn from the Corps of Royal Engineers. He received his commission during the South African War, in which he gained the Queen's Medal with three clasps. He was in the transport directorate at General Headquarters during the Great War, and has been chief inspector of the Research Department of the R.E. Stores. He has been six times mentioned in despatches. For the last four years he has been Assistant Director of Works at the War Office in charge of the electrical and mechanical engineering section. He was also Chairman of the Technical Committee of the Mechanical Warfare Board. During the past year he has carried out the onerous duties of President of the Institution of Mechanical Engineers in a manner which has been highly appreciated by the Institution and we wish him well in the important appointment he is now taking up.

The Duddell Medal.

THE Council of the Physical Society announces that it has awarded the thirteenth Duddell Medal to Dr. Charles Vickery Drysdale, for his outstanding work in connection with the design of electrical and optical instruments. Dr. Drysdale was educated privately and continued his scientific training at the Finsbury Technical College and the Central Technical College, South Kensington. He was for a time—1896 to 1910—Associate Head of the Department of Electrical Engineering and Applied Physics at the Northampton Institute, and he is a Past President of the Optical Society. He was a partner in the firm of Tinsley and Co., a position which he relinquished to join the Admiralty Experimental Station at Parkeston Quay, where he served from 1916 to 1919. He then became Scientific Director at the Admiralty Experimental Station at Shandon, and from 1921 to 1929 he was Superintendent of the Admiralty Research Laboratory at Teddington. He held the appointment of Director of Scientific Research to the Admiralty from 1929 to 1935, when he retired.

A New Type of Motor Lifeboat.

A NEW type of motor lifeboat, which will be named "Royal Silver Jubilee, 1910–1935," recently left the building yard of Groves and Guttridge, Ltd., of Cowes, for her station at Wells, Norfolk. She is the first of a new type, and is much lighter than any motor lifeboat at present in the fleet of the Royal National Lifeboat Institution. She weighs only 3½ tons, the next lightest in the fleet being nearly twice as heavy. Her length is 32ft., and she is driven by two 10 h.p. petrol engines of the Institution's latest design, and will have a speed of about 6¾ knots. She is fitted with a method of propulsion never before used in motor lifeboats, for instead of the ordinary propellers she has a Hotchkiss internal-cone propeller. This device consists of a steel cone in which the water is rotated by an impeller. One side of the cone is cut away, and the orifice thus formed allows the impeller to project slightly through the bottom of the boat. Centrifugal force causes the water drawn in at the apex of the cone to ride up the conical surface, and to be expelled with a greater velocity at the base of the cone tangential to the direction of rotation. This method of propulsion is being used as an experiment, and another motor lifeboat of the same new type, but fitted with a Gill shrouded propeller, will go to Ilfracombe. It is expected that these vessels will provide useful comparative data for motor lifeboats serving the British coasts.

A Machine Tool Merger.

THE announcement is officially made that from the beginning of February J. Parkinson and Son, the machine tool makers and ironfounders, of Shipley, Yorkshire, had taken over as a going concern the entire business conducted by the late Mr. Sam Sunderland at Fleece Mills, Keighley. It may be recalled by some of our readers that Mr. Sam Sunderland, the inventor of the Sunderland system of generating gear teeth, died suddenly last November. Since the year 1909 Parkinson and Son have been the sole licensees and makers of the Sunderland gear generating machine for spur, spiral, and double helical gears and up to date have supplied nearly 800 of these machines. Mr. Sunderland, however, used, through his own firm, to make and supply most of the cutters to Parkinson and Son. From the beginning of February that firm will manufacture and supply the cutters as well as the gear generating machines. It will retain in its service the staff of experienced workmen who were trained for this work under Mr. Sunderland's personal supervision.

American Beach and Shore Protection Works.

By E. E. R. TRATMAN.

No. V.

(*Continued from page 143, February 7th.*)

California Shore Protection.

As part of a state-wide system of highways in California and especially for the pleasure and convenience of its enormous tourist traffic, the Highway Division of the State Department of Public Works is completing a scenic highway along the entire length of its coast line, some 700 miles. In addition, there is the matter of preserving the great stretches of sandy beach for public use, and as an added attraction for visitors. Besides the increasing transient or tourist traffic, there is a continual increase in ocean-front towns and resorts along this coast line, so that stretches of beach now far from settlements will gradually come into public use.

This extensive project of the Highway Division

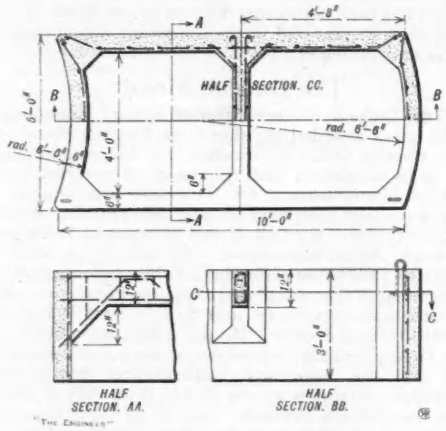


FIG. 33—PRE-CAST HOLLOW CONCRETE CELLS

requires—at various points—protective works for two distinct purposes: First, to prevent erosion of roads and road embankments, whether along the beaches, or on the rocky portion of the coast; second, to protect and maintain the broad sand beaches. The tidal range is only about 8ft., but there is very heavy wave action, due to the great depth of water near the shore. In several storms, the waves sometimes sweep over and damage roads 30ft. to 40ft. above high-tide level.

Concrete Cell Sea Wall.

Along a rocky part of the coast where the seaward slopes of the road embankments would extend practically to the water line, one method of protection was to build—in advance of the embankment—a toe wall at high-water line composed of precast hollow cells or bottomless boxes of reinforced concrete. These cells, Fig. 33, were 10ft. by 5ft. in

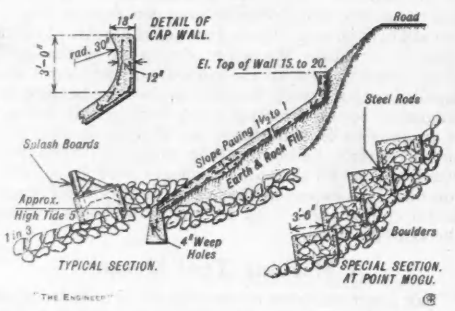


FIG. 34—USE OF CONCRETE CELLS IN CALIFORNIA

plan and 3ft. deep, with walls 6in. thick and a 6in. strut or beam 12in. deep across the top. One end was made concave, and the other convex, both with a radius of 6ft. 6in., so that cells placed end to end were interlocked. After being placed they were filled with concrete. The cells were handled and placed by a derrick or crane, with a hoisting sling attached to loops or stirrups at the corners of the cells. Each cell weighed about 3 tons, or about 12 tons when filled with concrete.

Two methods of using these cells are shown in Fig. 34. In some places—as shown at the left—a single row of cells formed a kind of breakwater for a concrete revetment above. In a few places—as at the right—several courses of cells were used, each course set back from the one below so as to form a stepped slope. In the latter case, steel reinforcing rods were laid diagonally in the concrete filling, as shown.

For the construction work, the loose rocks along the water line were arranged roughly by the derrick, small blocks being removed and longer ones shifted, if necessary, so as to project up inside the cells. With the cell in place, the rock bottom was sealed with quick-setting concrete so as to close the voids, and the cell was then filled with concrete and small rocks or "pudding-stones." In this way the toe wall became an integral part of the rocky shore. A temporary plank cover was placed on top to prevent erosion of the fresh concrete by the waves.

Where the toe wall is supplemented by a concrete revetment, as in Fig. 34, the slope of the embankment was dressed to a smooth surface with an inclination of about 1 on 1¼. On this was laid a paving of reinforced concrete about 20ft. wide, measured along the slope. It was in two sections, the bottom of the lower section, 12in. thick, butting against a low toe wall built behind the line of cells. The upper section, 9in. thick, butted against the lower one, the thickness of both slabs being increased to 16in. at the joint in order to provide ample bearing area. Loose rocks and boulders were piled behind the line of cells, and on the lower part of the revetment in order to break up the surge and wash of the waves.

Since heavy waves would run up this smooth revetment to a considerable height, its upper end was finished with a vertical wall 3ft. high and 12in. to 18in. thick. Its face is concave, with a radius of 2ft. 6in., so designed as to throw back the wave wash. Placing the lower part of the revetment could be done only at low tide and in calm weather. Even so, the workmen were usually soaked to the skin. To form a bulkhead or splash board to protect the men from spray, a post 6ft. long with plank braces, was placed in each cell before the concrete filling was deposited. To these posts were spiked lines of 3 by 12 planks.

Alternative Designs.

This construction, being slow and expensive, was used only to a limited extent. In other cases sea walls designed to throw back the waves were built at the top of a slope protected by rock revetment. Typical designs, as used near Ventura, are shown in Fig. 36. At A is the latest approved design, having a vertical face with projecting coping as a throw-back. When seated on a boulder formation, as shown, concrete is poured between the rocks to form a footing. At B and C are other designs to meet particular conditions. At C, an extension top with wave-deflecting coping or cornice, has been built on an existing wall. It is anchored by steel tie-rods hooked around the reinforcing bars in the wall and around a longitudinal bar embedded in a concrete anchor beam.

Where the California coast highway passes along the foot of Rincon Cliffs, south of Santa Barbara, it had to be carried outside of the embankment of the Southern Pacific Railway. Here a concrete sea wall was used, of the section shown at B, in Fig. 36. The new fill for the highway was about 10ft. high, with a 30ft. road and 10ft. walk, but for the sake of appearance the sand filling was continued back to the slope of the railway embankment.

This concrete sea wall is 21ft. high, but is of much thinner section than other walls previously described. The base is 8ft. wide for a footing 3ft. high, above which the face is concave. From the footing a curve of 7ft. 11in. radius is followed by an inclined tangent and then a curve of 17ft. 2in. radius; this in turn runs into an outward curve of 4ft. 10in. radius, which ends in a rounded coping and forms the throw-back for waves. The wall was built in 30ft. lengths, with tongued and grooved expansion joints. Its upper part forms a parapet 3ft. 6in. high.

A low-cost form of protection for the highway embankment consists in excavating a trench along the toe to a depth of 5ft. or 6ft., and filling this with quarry blocks of 1 to 4 tons weight, which are piled

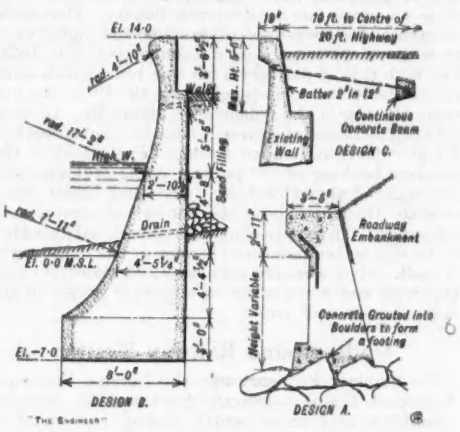


FIG. 36—SEA WALLS ON CALIFORNIAN COAST

up to about 10ft. above ground, on the slope of the embankment. The trench forms an anchorage for the foot of the rock wall or revetment.

Steel Pile Sea Wall.

One of the latest types of sea wall along highways of the California coast, shown in Fig. 35, is a radical departure from earlier typical designs, being of the braced vertical type, with the wall proper consisting essentially of a line of interlocking steel sheet piling. This design is used along sandy beaches. A concrete wall will be noted along the left side of the road. This is part of a former sea wall which had to be removed to permit of widening the heavily travelled

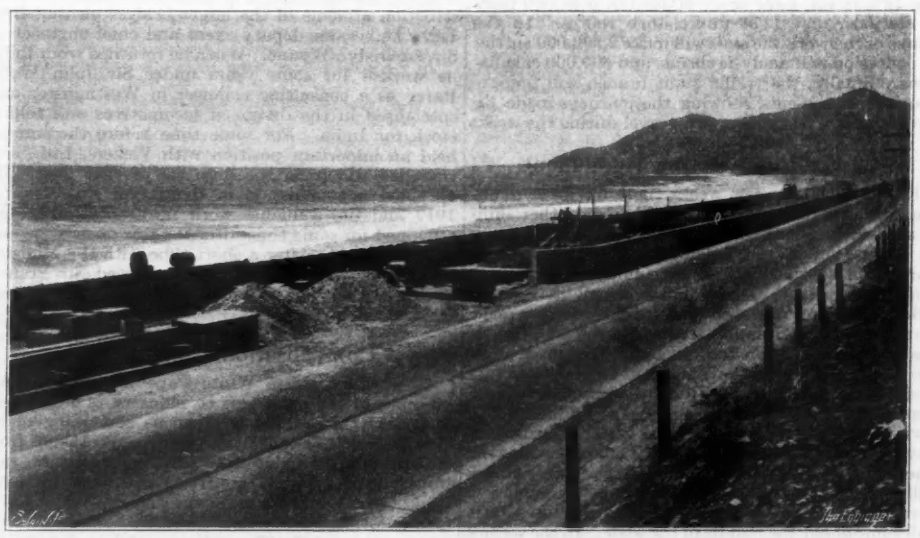


FIG. 35—STEEL PILE SEA WALL ON CALIFORNIAN COAST

Coast Road. Outside of this older wall is the long line of steel sheeting for the new sea wall.

In this newer steel design, shown in detail in Fig. 37, the piles are of trough section, placed alternatively with their faces concave and convex. Bolted along either side at the top are two waling pieces, 8in. by 8in., covered by a cap timber, 6in. by 18in., all of creosoted Douglas fir. A special feature is an inclined throw-back plate to divert spray or waves. Its upper face is bolted against the outside wale, and its lower face is cut and bent to fit the channelled face of the sheeting. The backs of the piles are painted with hot asphalt, and back filling is placed behind them.

The piles are about 17ft. long, or as required by local conditions, and extend 6ft. to 8ft. above the normal surface of the ground. Every sixth pile, however, is of extra length, 22ft. where 17ft. piles are used, to serve as an anchor pile. At intervals of about 10ft., the wall is anchored by diagonal tie-

rods, bolted through the wales and extending back to be embedded in concrete anchor blocks, 3ft. square and 18in. thick. These blocks are cast in place around the ends of the rods. A clevis or turnbuckle enables the tie-rod to be drawn taut or put under tension. These rods and anchors are buried in the back filling behind the wall, the toe of the embankment being at the top of the wall.

Groins are required in connection with these sea walls in order to check the continual southward shifting or littoral drift of the beach. These groins are of steel sheet pile construction, about 200ft. long and spaced 500ft. to 600ft. apart. The piles are 12ft. long at the shore end and 18ft. at the outer end, where the depth of water is 10ft. to 12ft. Two wales of rolled steel channels are bolted against the tops of the piles and upon them is bolted a creosoted pine cap timber, 6in. by 12in. Experimental groins of concrete have also been built.

CHICAGO LAKE-FRONT PROTECTION.

The city of Chicago has a great extent of public parks along its Lake Michigan frontage, but this frontage is exposed to the fury of lake storms, which have caused serious damage and shore erosion at times. Since the lake is some 300 miles long and 80 miles wide, with Chicago at its south-western corner, the north-east storms have a long sweep over open water. Protective works have been necessary, therefore, to preserve the beaches and shore property. Here, however, it has been not so much a matter of protecting an existing shore line, but rather the establishment and maintenance of a new shore line for hundreds of acres of park on new or made land. Thus much of the construction work has been in water 12ft. to 20ft. deep, fully exposed to storm attacks.

PAVED BEACHES.

An unusual type of shore work is what is termed "paved beach," which extends for some miles along the water front of both Jackson Park and Lincoln Park. This is intended to absorb or check the energy in the rush of the waves, but severe storms still cause great damage to the structure. In ordinary weather it is dry, the toe being at about the normal water level of the lake.

The general design of the work at Lincoln Park is shown in Fig. 38, but concrete paving was substituted for stone block paving on parts of the work. In the earlier construction there was a sea wall 10ft. wide, with its top 2ft. above normal lake level, where the water is 6ft. to 12ft. deep. The lake side of the wall consists of a close row of 30ft. round piles driven in contact with each other, behind which is a sheeting of a single line of 3in. by 12in. planks, 20ft. long—not interlocked. Waling pieces along both sides at the top are bolted through the piles. The inner or land side of the wall has a single row of round oak piles, 25ft. long and 6ft. apart, with plank panels between them and bolted to a waling piece. At each of these piles a tie-rod extends across the wall to the opposite pile on the lake side. The 10ft. space between the two rows of piles is filled with cedar bark to within 5ft. of the water line, above which is heavy limestone rock.

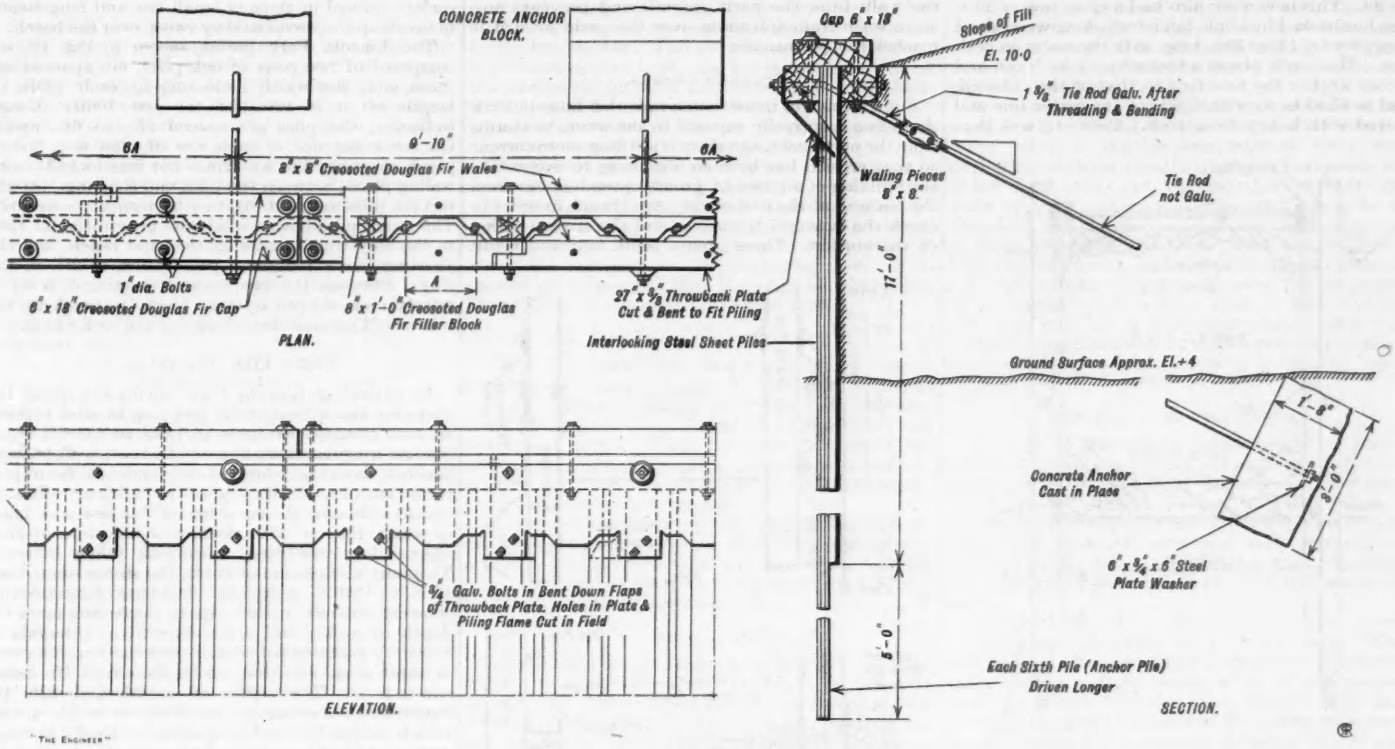


FIG. 37—DETAILS OF STEEL PILE SEA WALL

From the landward side of this sea wall or bulkhead the "beach," paved with granite blocks or concrete, slopes up on an incline of 1 in 8 for a distance of 40ft. to the foot of a stepped 3ft. masonry wall which retains the park ground and a 16ft. concrete promenade. The granite blocks were laid on a gravel bed on sand filling and were pointed with cement mortar. The original design called for blocks 18in. deep over the rock filling of the sea wall, but as actually constructed this filling was left uncovered. In some later

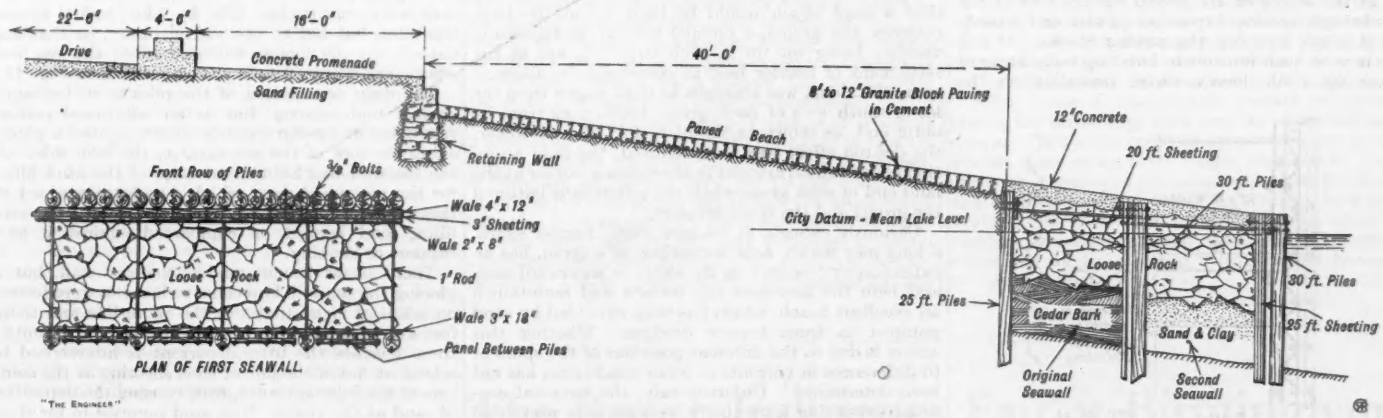


FIG. 38—PAVED BEACH AT LINCOLN PARK, CHICAGO

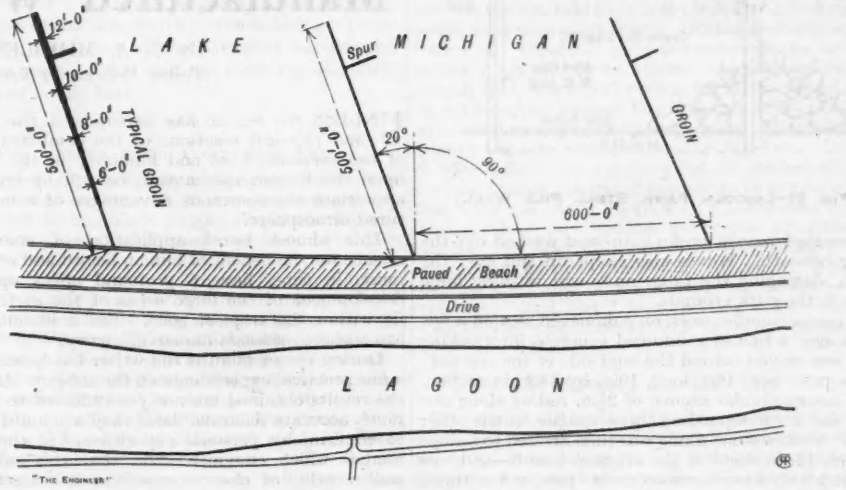


FIG. 39—SPURRED GROINS AT LINCOLN PARK

work a paving of concrete 5in. thick was used instead of the stone blocks, generally in slabs for the full 40ft. width of the beach, but sometimes in panels 12ft. square, with asphaltic filling in the joints.

A few years later about 1000ft. of this work was reinforced by a second sea wall of similar construction built against the front of the old wall—as is shown by Fig. 38. This new work also had a close row of 30ft. piles, but backed by triple-lap interlocking wood sheet piling, 9in. by 12in., 25ft. long, with top wales on both sides. The top is about a foot above lake level, and tie-rods anchor the new face to that of the old wall. Sand is filled in to within 5ft. of the water line and covered with heavy loose rock. Concrete was then

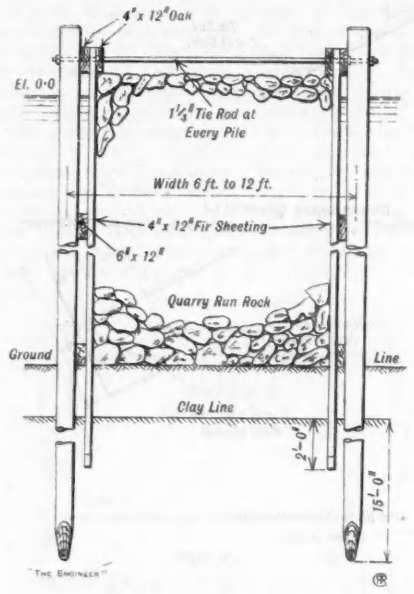


FIG. 40—LINCOLN PARK GROIN

placed over the rock to a minimum thickness of 12in., and finished to a continuance of the 1 on 8 slope, Transverse and longitudinal partitions in the filling were built under the paved slope to limit any leakage or washout.

Decay, irregularities, and breaks in the sheet piling gradually admitted water, which washed out pockets in the sand filling. In storms, also, the surge and wash of the waves on the paved surface sucked out sand through cracks, expansion joints, and loosely grouted joints between the paving blocks. Water drove in with such force as to burst up large areas of the paving, while heavy waves pounding on the

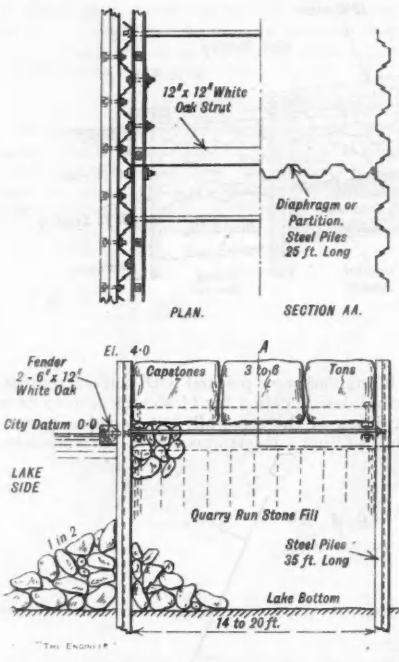


FIG. 41—LINCOLN PARK STEEL PILE WALL

undermined paving broke it up and washed out the filling beneath. Waves also swept up and over the beach, damaging the promenade and washing large holes in the park grounds.

In reconstruction work on a damaged section a few years ago, a line of reinforced concrete interlocking piles was driven behind the land side of the sea wall. These piles were 16ft. long, 10in. by 18in. in section, with a semicircular groove of 2½in. radius along one edge and a corresponding lip or tongue on the other edge. Broken stone filling was then dressed to a slope of 1 on 12—instead of the original 1 on 8—and was covered with a reinforced concrete paving 8in. thick, laid in slabs 48ft. long and 30ft. wide. Steel rods, 8ft. long and 10ft. apart, were bolted through the sheet piles and attached to anchor plates 4in. by 5in. embedded in the concrete slab.

A new promenade of 5in. concrete was built, level with the top of a new 3ft. retaining wall of concrete along the upper end of the beach. On the far side of the walk a concrete dwarf wall, 2ft. high, separates the walk from the park grounds and prevents any wave wash from spreading over the park, even if it reaches the promenade.

SPURRED GROINS.

For a stretch of more than a mile this Lincoln Park shore line is specially exposed to the waves of storms from the north-east, and there is a strong shore current so that erosion has been so serious as to necessitate the building of a series of groins extending out from the sea wall at the foot of the paved beach in order to check the sweep of the waves and the erosive action of the current. These groins, 500ft. long and 600ft.

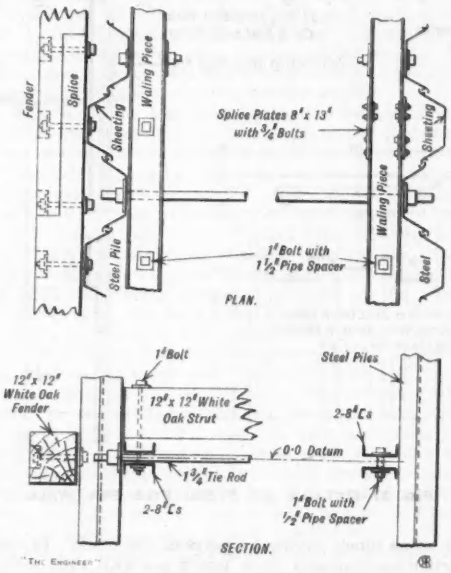


FIG. 42—LINCOLN PARK STEEL PILE WALL

apart, extend practically north-east or at an angle of 110 deg. with the line of the sea wall.

By intercepting the shore current, it was expected that a sand beach would be built up in the bays between the groins, a circular current of decreasing velocity being set up in each bay. To aid in the settlement of matter held in suspension, a diagonal spur, 50ft. long, was built out at right angles from the lee or south side of each groin, 100ft. back from its outer end, as shown in the plan, Fig. 39. However, the desired effect was not produced, the only accretion being a small amount in the extreme corner at the land end of each groin, while the waves have battered the groins and the spurs severely.

Curiously enough, at Jackson Park, further south, a long pier which acts somewhat as a groin, has an extension or "spur" on its north or windward side, and here the accretion has formed and maintained an excellent beach, which has been extended by sand pumped in from hopper dredges. Whether this action is due to the different positions of the spurs or to differences in currents or other conditions, has not been determined. Unfortunately, the financial conditions resulting from the depression have prevented the carrying out of remedial works on the paved beaches, but in the section where the groins were necessary, at Lincoln Park, it seems probable that permanent construction will include a sea wall of steel piling and masonry built up to a little above normal lake level, outside the ends of the groins, and followed by a long concrete paving on a flat inclination, extending back some 60ft. or more. It is possible that such a paved beach might have the surface formed in steps of small rise and long treads to break up the waves as they sweep over the beach.

The Lincoln Park groins, shown in Fig. 40, are composed of two rows of oak piles, 6ft. apart at the shore end, the width increasing at each 100ft. of length till it is 12ft. for the last 100ft. Longitudinally, the piles are spaced 5ft. to 6ft. apart. On the inner side of each row of piles is a line of plank sheeting, 4in. by 12in.—not interlocked—with waling pieces between the piles and sheeting. At the top the piles are held together by transverse tie-rods. The round piles have a minimum penetration of 15ft. in the clay which underlies the sand beach, and the sheeting has a minimum penetration of 2ft. in the clay. Between the two lines of sheeting is a fill of quarry rock, capped by huge blocks to break up the waves and prevent disturbance of the rock filling.

STEEL PILE SEA WALL.

In extending Lincoln Park northward along the shore for about 2 miles, by pumping in sand to form an area of some 500 acres in front of the old shore line, an irregular shore line was laid out, with bathing beaches, boat harbours, and islands to form protected lagoons. For the sea wall or bulkhead—Figs. 41 and 42—defining the outer line of this new park land, in water 15ft. to 23ft. deep, a double line of steel sheet piling was used, with rock filling between. To assure a minimum of voids, the stones range from 10 lb. to 1500 lb. in weight. The lines of interlocking sheeting are 14ft. to 20ft. apart, depending upon the depth of water, and are connected at intervals of 100ft. by partitions of similar construction, composed of sheet piles, 25ft. long, with their tops 1ft. below water level. These piles are interlocked with the longitudinal sheeting. The filling of rough quarry rock is capped by roughly squared blocks of 3 to 6 tons weight, and 4ft. deep, having their upper surfaces flush with the top of the sheeting at about 4ft. above mean lake level. These cap stones prevent disturbance of the interior filling by heavy waves.

The piles are 42ft. long with their tops 4ft. above mean lake level. At the water line are inside waling pieces, each consisting of a pair of rolled steel 8in. channels laid flat and back to back. The tie rods pass between the backs of the channels. Timber transverse struts, 12in. by 12in., are also fitted between the waling pieces. Along the water side of the sea wall is a fender timber, 12in. by 12in., bolted against the piles, but not to the waling pieces, so that any damage to the fender will not affect the sea wall structure. These details are also shown in Fig. 42.

The deep penetration of the piles is an insurance against undermining, but as an additional precaution a toe of rip-rap stone or quarry blocks is placed along the foot of the sheeting, on the lake side. As the sea wall was built in advance of the sand filling for the reclaimed area, which was later pumped in, this wall had to serve as a breakwater until the sand filling had settled or compacted against it as a support or backing.

There is no beach outside the sea wall, but in placing the sand fill two concave beaches were formed on inlets at right angles to the shore line and therefore away from the direct wave attacks. To maintain these beaches the littoral current is intercepted by a hooked end of the line of steel sheeting at the south side of the inlet entrance, thus causing the deposition of sand at the beach. The sand pumped in for these beaches was dressed to a slope of about 1 on 100.

(To be continued.)

Manufactured Weather in the Tropics.

By C. A. MIDDLETON SMITH, M.Sc., M.I. Mech. E.
(Taikoo Professor of Engineering in the University of Hong Kong).

UNLESS the reader has experienced the mental and physical reactions of the combined effects of the excessive heat and humidity in the Tropics upon the human mechanism, he will be unable to appreciate the enormous advantages of a manufactured atmosphere.

This almost latest application of engineering science for the benefit of human health and efficiency must, in time, have a profound effect upon the development of the large areas of the earth which lie within the tropical zone. For a manufactured atmosphere increases human efficiency.

During recent months the writer has been making a few practical experiments on the subject. Although the results obtained are not yet sufficient to provide much accurate scientific data, they are quite enough to confirm, by personal experience, the theoretical studies which convinced him that this subject is well worthy of close commercial investigation by British firms manufacturing refrigerating machinery. And it is with the primary object of stimulating an interest in Britain in an engineering development that is, at present, in its infancy that this matter is discussed. For the British Flag flies over many thousands of square miles that are in the Tropics. And the Empire can be made more productive by an increase in the application of science to local problems.

It is a truism that where the banana grows there the natives are, and apparently always have been, less energetic, and therefore less civilised, than residents in colder regions. It is, of course, true that there is not much incentive to store or even to cultivate food, or to provide protection against the weather in a climate where Nature allows edible vegetation to flourish almost without attention, and where the inhabitants require but little covering. But that is not the whole of the story. For the Englishman is at work in the Tropics, and he does not easily resign himself to local conditions.

When the white man arrives near the Equator, he is appalled by the sights which spell out inefficiency in letters of fire that burn into his brain. Especially affected is the white man who has had an engineering training. He knows enough about health and sanitation to realise, at a glance, that ignorance on these subjects is affecting adversely the lives of the natives.

Steeped in the traditions of efficiency, the energetic British engineer attempts to reform the conditions that appal him. The religious reformer has, perhaps, a less exhausting task. But whatever their mission may be, white men in the Tropics soon feel the effects of the enervating climate, and in the popular magazine stories, that fascinate city typists, the rapid deterioration in the morale of the white man in these regions, which is vividly described, has a foundation of truth.

It can, however, be accepted as fact that the majority of our countrymen remain true to the "home" type, even although we must acknowledge that their tempers are easily upset when the heat and humidity is something which those who dwell only in England have never experienced. In the course of time it does have a lethargic effect both upon body and mind.

Human Efficiency.

There have been many definitions of the engineer, but it is not claiming too much to suggest that one great result of the collective endeavours of members of the profession has been to increase human efficiency.

It is because the conquest of the enervating climate of the Tropics must increase human efficiency that an appeal is made to engineers to become interested in the subject of manufactured weather for offices and homes in the Tropics.

After many years of investigation it has been possible to install a small air-conditioning plant in my office in the Hong Kong University. It has been at work for about six hours a day during the last week, and the benefits obtained from it and the low cost of operation, have convinced me that when residents in a humid climate begin to realise these facts, there will be quite as much demand for these air-conditioning machines as there now is for the comparatively new apparatus called household refrigerators.

Incidentally, it may be mentioned that this small apparatus now in use in the University is fitted inside a cover of appearance rather like a gramophone or wireless cabinet. The outside dimensions of this cover are 39in. by 26in. and 27in. high.

The machine makes no more noise than does an ordinary fan; indeed, it is probably the exit air through the grating in the top of the cover and the fan that cause the purring sound, which is not at all irritating to a mental worker.

It is only during recent years that small household refrigerating machines have been in use. Formerly, we preserved the food that otherwise would soon become unfit for consumption in the unsatisfactory —even unhealthy—wooden ice-box. Now we use a motor-driven tiny compressor with cold coils in a sheet iron cabinet.

In the usual type of household refrigerating machine there is no water circulation, for it is unnecessary when the heat carrier is SO_2. Water cooling is employed in my small air-conditioning plant, in which the heat carrier is called "Freezon." This water circulation may, or may not, be an advantage. My own experience is that it is an advantage, as the hot water obtained is supplied to students in an adjoining laboratory, and it helps them to "clean up" after handling machinery in their experiments.

Some Interesting Figures.

The plant was installed in a small room of about 175 square feet floor area and 18ft. in height. It was switched on at 8.30 a.m. on April 17th when the atmospheric temperature was 72 deg. Fah. and humidity 91 per cent. At 10.15 a.m. the room temperature was 69·5 deg. Fah. and the humidity was 86 per cent. Not only had the temperature of the room fallen, but the machine condensed 12·88 lb. of water from the atmosphere in six hours.

The temperature of the room steadily fell until it reached 67·1 deg. Fah., and the humidity remained practically constant at 86 per cent. If the humidity figure remains constant as the temperature falls, the number of grains of water per cubic foot of air falls with the temperature. The main use of the machine is to condense the water vapour.

The mean temperature of the atmosphere outside during the test was 75 deg. Fah., and the mean humidity was 85 per cent.

The total cost of the energy consumed during the test of six hours, at 5c. local currency per unit, was 25c. Although our local silver dollar fluctuates with the price of silver, we may reckon it at 2s. to the dollar, or, say, at about 1d. per hour for the electrical energy consumed.

The figures obtained concerning cooling water were surprising. It will be remembered that the heat carried away by this water is not only the equivalent of the work done, but also includes the heat abstracted in cooling and condensing the refrigerant. It does not, of course, include the energy consumed by the fan; but that was only 40 watts.

We used 3·45 lb. of circulating water per minute during the six hours of test. The cooling water was raised 37·6 deg. Fah. in temperature—that is to say, 130 British thermal units per minute were carried away by the cooling water.

If we subtract from the heat carried away by the cooling water the equivalent in heat units of the electrical energy recorded by the wattmeter used by the machine, we have an idea of the heat abstracted by the heat carrier. This gave an (overall) coefficient of performance at 1·64. As the energy recorded by the wattmeter includes that used in a small transformer, used to step down from 200 volts to 100 volts, and that used by the fan, the actual coefficient of performance of the machine was 1·9.

The figures were obtained when the room was unoccupied, except during the short period at the end of each two hours when readings were taken.

Although no figures are available for the initial cost of the machine, if we remember the price of household refrigerators for preserving food, it is reasonable to suppose that they can be supplied in Hong Kong for some price less than £100.

The Ideal Conditions.

These few tests have been made under general conditions of climate that are by no means the worst experienced in this part of the world. For although Hong Kong has a very delightful winter, those who have lived both in Hong Kong and Singapore tell us that there are days during the summer months in Hong Kong when the climate is far worse than anything experienced in Singapore.

It is therefore fairly certain that if we wish to manufacture an atmosphere with temperature and humidity that is within what experiments in America call "the comfort zone," the ordinary sized living-room will require a larger machine.

The Ideal Climate.

Experiments on animals subjected to different degrees of temperature and humidity, in order to observe the degree of exhaustion produced under different conditions of atmospheric temperature and humidity, have been made. The following results are taken from "Mind and Work," by Dr. Charles Myers. He states that with a temperature of 69 deg. Fah. and 52 per cent. humidity the work done was at a maximum, and records it as 100. It was found that with a temperature of 75 deg. Fah. and humidity 70 per cent. the figure for work done was 85, and with a temperature of 91 deg. Fah. and humidity 90 per cent. the figure was 76.

Those figures may be applicable for men doing manual work, but the writer is convinced by general observation of many hundreds of Chinese students, European commercial men and colleagues, and the record of his own endeavours in the ideal winter conditions and the distressing summer climate of Hong Kong, that a much greater loss in efficiency takes place when mental effort is considered.

Those who have had the experience of living in a submarine, submerged for several hours in tropical waters, explain that the time factor is important. If they are submerged daily for twelve hours, and on the surface at night, the lethargy is much worse after ten days than after two or three days on duty.

It is, unfortunately, not easy to devise a system of measuring mental effort. That employed by Dr. Haldane, F.R.S., and others, for measuring the variations in physical work under different climatic conditions, seems to be fairly reliable. But the human brain is a much more complicated mechanism than the muscular apparatus of animals or men. So curious are the emotional reactions of individuals that "what is one man's meat is another man's poison." That is true, not only of food, but of endeavours to produce happiness, and, therefore, useful mental work. It is certain that the human intellect does fall off in efficiency in a hot and humid climate, even if we cannot record the decline in a percentage value.

A most noticeable result of excessive heat and humidity is revealed in the recuperative effect of sleep. It is a common complaint in Hong Kong during the summer months amongst Europeans that either they sleep only in snatches or that they wake up feeling weary and exhausted. Asiatics are generally speaking so unobservant and inaccurate in their statements that it is difficult to be sure of their reactions in this matter, but the climate certainly does affect them. Their *tempo* slows up perceptibly in the summer, and a great deal of their daylight leisure is used up in the endeavour to sleep. An air-conditioned bedroom in the Tropics must produce more restful sleep than one with a hot and humid atmosphere.

The House in the Tropics.

A study of this subject compels us to visualise houses of the future in these hot and humid climates, as something entirely different in design from those in use to-day. For it is now a characteristic of dwellings for Europeans and the better-class Asiatics that large areas of windows, easily opened, are included in the design. The idea is that the benefit of any summer breeze can be obtained in the spacious rooms.

Unfortunately, these large window areas admit sunshine, and therefore heat, when closed. When opened they often provide comparatively little relief unless there is a strong breeze, which seldom happens when heat and humidity is excessive. We may therefore imagine the house of the future with steel-framed windows of dimensions designed only to give sufficient daylight.

There is, of course, nothing novel about a cooled and dried atmosphere; that has been provided for several years in certain industrial undertakings. It is now being introduced in large commercial buildings in the Tropics. In Hong Kong a well-known British firm is installing an air-conditioning plant for the largest building in the colony, viz., the head office of the Hong Kong and Shanghai Bank. Incidentally, this splendid structure is said to be the first building in the world in which the whole of the steel frames is of high-tensile chromador steel. The air-conditioning plant, with the necessary circulating pumps for cooling water, is equipped with electric motors totalling about 450 e.h.p.

What is new is the evolution of small refrigerating plants for preserving food and for air-conditioning rooms. That is the problem upon which one or more British engineering firms might concentrate. It is, of course, a matter of producing apparatus as compact and as economical as possible. It will be a great stimulus to enterprise in the Tropics when the problem is solved, so that these machines can be considered as an essential fitting in the homes of professional men.

The British Industries Fair at Birmingham.

No. I.

THE Engineering and Hardware Section of the British Industries Fair opens at Birmingham next Monday, February 17th, and will remain open until the 28th. With this issue we publish an eight-page Supplement descriptive of the exhibits. In our next issue also there will be a similar Supplement, and some pages of this and the following issues will be devoted to the Fair.

The United Steel Companies, Ltd.

The group of companies comprising the United Steel Companies, Ltd., 17, Westbourne-road, Sheffield, claims to be able to supply the needs of practically every trade using steel and iron. For this year's exhibition the companies' stand has been sectionalised "by trades." Several principal industries have been chosen and a range of the products supplied for each one is being shown. In the railway section Steel Peech and Tozer will be showing railway and tramway wheels and axles, a locomotive crankshaft, and a range of tires, discs, and solid wheels. A bored axle, showing the cleanness of the bore is also displayed. The Workington Iron and Steel Company will be showing rails and steel sleepers; while Daniel Doncaster and Sons, Ltd., manufacturers of all types of light forgings, will be showing a finished connecting-rod with a connecting-rod forging, together with drawbar hooks, piston-rods, and slide bars.

A range of commercial vehicle springs will be shown by Samuel Fox and Co., Ltd., in the road and aircraft section, and the display will also include gears made in various alloy steels. Examples of the application of "Diamet" inspected steels in the aircraft industry are also to be shown. In the engineering section cold rolled steel strip in various qualities is to be exhibited by Samuel Fox and Co., Ltd., together with some examples of the wide range of the different qualities of wire manufactured by this firm. United Strip and Bar Mills will show hot-rolled steel strip in various finishes. Another product to be displayed by this branch is barrel hoops with a galvanised finish. Among alloy and special steels the products of Samuel Fox and Co., Ltd., are interesting. The exhibits will include examples in "Durehete," a creep-resisting steel now in use in many important power stations; "Red Fox" heat-resisting steel; casting steels for dies and moulds; and "Diamet" inspected steels.

Edgar Allen and Co., Ltd.

Two stands will be found bearing the name of Edgar Allen and Co., Ltd., Imperial Steel Works, Sheffield, 9; one devoted to machinery, &c., and the other to tools, dies, &c., of special alloy steels. We illustrate three of the more novel machines in Figs. 1, 2, and 3.

That shown in Fig. 1 works on the principle of a patented excentric motion, incorporating two main duplex bearings, each fitted with two roller races in the same housing, the inner races being arranged excentrically and transmitting a throw to the body of the machine, thus giving a positive vibrating motion to the screens. Perfect balance is given to all moving parts, resulting in a smooth and even motion of the whole machine. The body of the screen is supported from the frame by springs, so that the weight of the body has not to be taken by the bearings. A special feature of the design is the ease with which screen meshes can be changed, also the accessibility of all working parts. The following are the principal advantages of the screens :—(1) Can be used for wet or dry screening ; (2) will run in either direction of rotation ; (3) have a grading efficiency of 95 per cent.

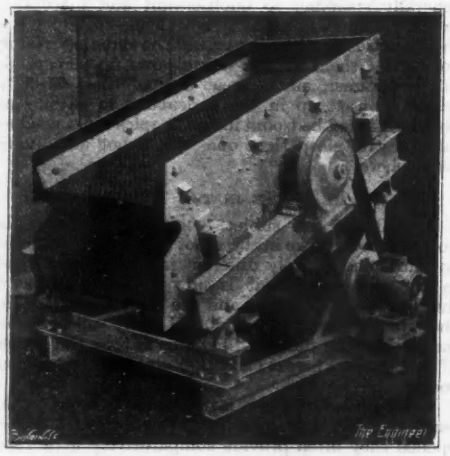


FIG. 1—VIBRATING SCREEN—ALLEN

and over ; (4) only two bearings, mounted as far as possible from dust or damp ; (5) all parts readily accessible ; (6) driving mechanism entirely housed ; (7) all parts made to gauge and interchangeable. The screen is made in sizes ranging from 2ft. wide by 4ft. long to 5ft. wide by 12ft. long.

The Edgar Allen Imperial patented scrubber and washer, see Fig. 2, is a new type of machine generally used for scrubbing and washing such materials as gravel, dirty stone, sand, coal, and similar materials. They are designed with a view to saving space, horse-power, labour, and wear and tear of parts, and have many new features which will appeal to users of this type of plant. The Imperial scrubber and washer works on the vibrating system and is made in sizes ranging from 10in. wide by 3ft. long to 24in. wide by 6ft. long. Capacity varies, of course, according to the nature of the materials to be handled.

The new rotary granulator, illustrated by the

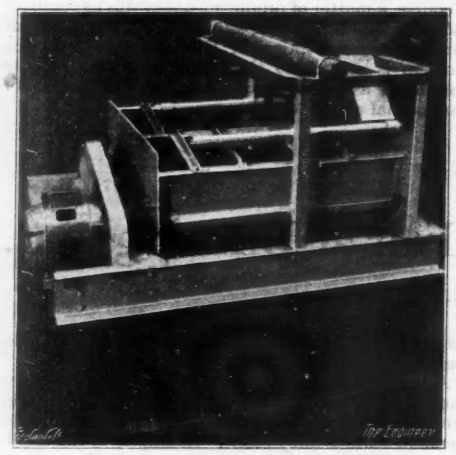


FIG. 2—SCRUBBER AND WASHER—ALLEN

sectional drawing Fig. 3, is designed to reduce the material by impact and not by grinding action. All working parts are readily accessible, and are constructed to withstand hard wear. The heavy manganese steel hammers are in the form of solid bars and are designed to give four faces exposed to wear, by reversing the hammers. The direction of rotation is towards the feed opening and the incoming material to be crushed is thrown with great force upon the special manganese steel liners arranged all round the inner surface of the steel casing in such a manner as to give the greatest amount of crushing surface. The feed mouth is extended so as to overcome the tendency for the material to be flung out through the opening, and is provided with manganese steel renewable liners. Crushing is caused by impact against the heavy manganese steel breaking blocks, which are corrugated to present the maximum surface for crushing. One of the liners, named the breaking plate, is made adjustable by means of a strong screw and hand wheel, so that the clearance between the rotating hammers and the liner can be set to give the correct crushing effect and also to take up wear. Easy access is provided by the door shown in the drawing, which enables the breaking blocks, adjustable breaking plate, and liners to be removed with despatch. Furthermore, the hammers are made

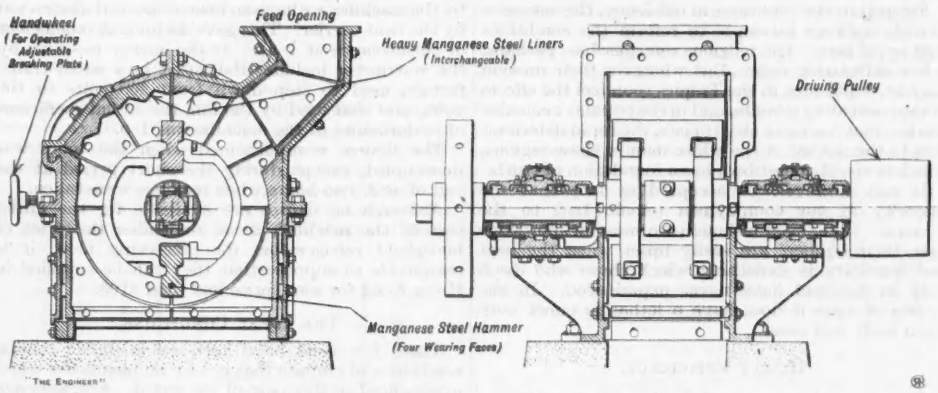


FIG. 3—ROTARY GRANULATOR—ALLEN

readily accessible by the door, which enables them to be changed in a very short time.

The degree of reduction can be controlled by (1) adjusting the breaking plate, (2) regulating the speed of the rotor of the machine. These adjustments enable the product to be controlled within certain limits varying from 2½in. cubes maximum downwards. The size of the pieces which the granulator will handle depends largely upon the hardness and abrasiveness of the material to be crushed. The machine is made in four sizes having capacities from 6 to 60 tons per hour of limestone or 3 to 20 tons of granite.

STEWARTS AND LLOYDS, LTD.

The firm of Stewarts and Lloyds, Ltd., of Glasgow, Birmingham, and London, is exhibiting a range of products consisting of pig irons, steel strip, and sections, and steel castings, but the chief display will consist of tubes and their accompanying fittings.

FIG. 4—LONG SLEEVE JOINT—STEWARTS

Among these the Dawson joint for high-pressure steam will be shown as used with and without flanges. The latter type has been approved for power station work by several insurance companies. The Victaulic joint and the Johnson coupling are also to be seen, as is the Camac tap with its range of adapters. An interesting joint which is being demonstrated is the Stewarts long-sleeve taper joint for underground gravitational sewers. It is illustrated in Figs. 4 and 5. In this joint no lead and yarn or other jointing material is used. Both spigot and socket are tapered, and when driven together make a sound joint. The excavation necessary and the cost of jointing are both greatly decreased. In the smaller sizes each pipe when lowered and while still hanging on the tackle is used as a "dolly" to drive the previous pipe home in the tapered socket. On the larger sizes lugs are provided as shown in the illustra-

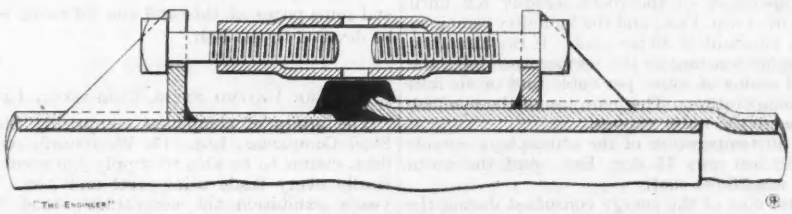


FIG. 5—LONG SLEEVE JOINT WITH RIGGING SCREW—STEWARTS

tion into which a rigging screw fits. When the rigging screw is tightened it draws in the top side of the spigot and this tends to raise the other end of the pipe, but the weight of the pipe forces in the lower side of the spigot, and so the one screw draws the joint together evenly. It might be expected that several screws would be required, but one is found to be more efficient, as well as quicker and less costly. A similar system is adopted to facilitate the laying of large diameter pipes with lead and yarn joints.

THE STAVELEY COAL AND IRON COMPANY, LTD.

A wide range of products will be displayed by the Staveley Coal and Iron Company, Ltd., of Staveley, near Chesterfield. The range will include various grades of coal and pig iron, Staveley tarred slag for road-making, and Stabita, a scientifically blended mixture of high-grade coke-oven refined tar with bitumen for road spraying and similar purposes. In addition,

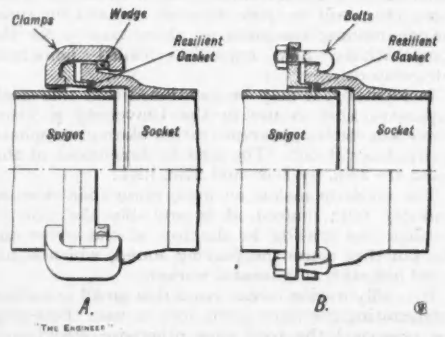


FIG. 6—FLEXIBLE PIPE JOINTS—STAVELEY

the firm is to display a range of chemicals for commercial use. The Staveley sand spun pipes and pit cast pipes will also be shown, both with and without various linings and coatings. The sand spun pipes are centrifugally cast in sand-lined moulds, and all internal strains are removed so that the pipes are capable of withstanding shock to a remarkable degree. In addition, they have the useful quality of a high degree of flexibility. As well as the normal types of jointing, the Staveley flexible joints will be used to connect samples. These joints allow an 8 deg. leakproof movement in any direction, and are easily and quickly made even by unskilled labour with the assistance of a spanner only. We illustrate the new type of joint in Fig. 6 B, while an older version, which was described in THE ENGINEER B.I.F. Supplement for 1933, is shown for comparison purposes in Fig. 6 A. The improvement consists of replacing the clamps and wedges formerly used by hook bolts and nuts. As will be seen, the simplification achieved is considerable. In cases where it is preferred, the older type of joint may still be obtained, and in some types of work it may have certain advantages. The design of the joint consists of a special socket and spigot. The socket is provided with an annular shoulder against which a resilient gasket is arranged to abut when the joint is made. The back of the shoulder is tapered to enable angular movement of the spigot end to take place. The resilient gasket is a "grip fit," both on the spigot and in the socket, which is tapered to allow the gasket to enter. A pressure ring of special shape bears on the gasket,

pressure being applied by the screws or clamps according to the type of joint, this being the only difference between the two types.

NORTHEY ROTARY ENGINES, LTD.

The compressors and vacuum pumps to be exhibited by Northey Rotary Engines, Ltd., of 45, Richmond-road, Parkstone, Dorset, operate on a principle which combines the advantages of rotary motion with the ability to produce high pressures or vacuum readings normally inherent in the reciprocating machine. The ability of these machines to build up a high pressure results from the air being enclosed

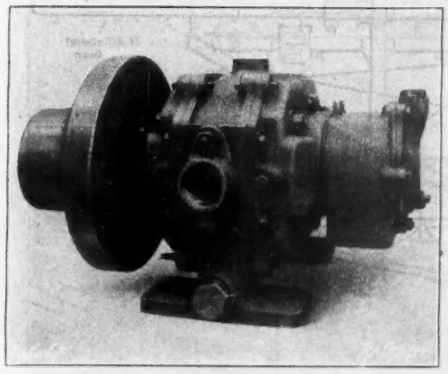


FIG. 7—ROTARY PUMP—NORTHEY

within the space swept by two approaching arms which carry out the compression very rapidly. A seal is produced as the rotors form a definite barrier to air leaks through the valve openings. As the action of the compressor is "compounded," a two-stage effect is obtained, since in its path through the compressor each particle of air must be transferred from the suction side of one arm to the compression side of the other. A consideration of Figs. 8 A and B will make the principle of operation clear. It will be seen that the machine consists of a chamber formed by two intersecting cylinder bores. Within these

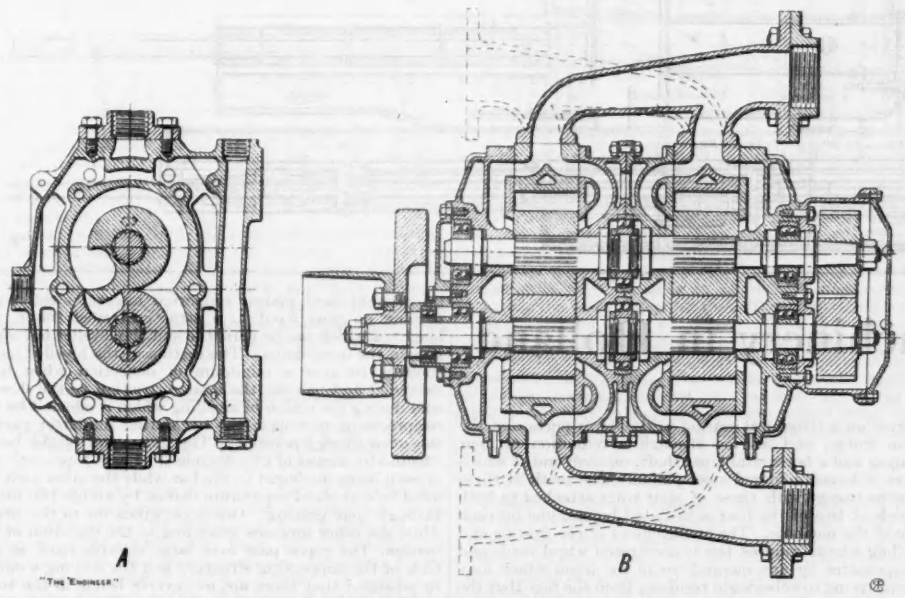


FIG. 8—SECTIONS OF ROTARY PUMP—NORTHEY

bores two rotors revolve simultaneously in opposite directions, being carried on two parallel shafts. The shafts are coupled by equal gear wheels at one end, thus maintaining the rotors in correct relationship to each other. The rotors do not come into contact with each other or with the walls of the cylinder. Admission and delivery ports, which take the place of valves, are covered and uncovered by the rotors themselves during each revolution. As the rotors move from the position shown in Fig. 8 A—which shows a section through the machine, the "valve operation" being shown more clearly in the plan 8 B—the space enclosed by the "trailing" sides of the arms increases and the entry of air is induced *viâ* the inlet port. At the same time the area enclosed by the "advancing" sides of the arms is decreasing, and the air therein is being compressed. The end of the compression stroke is reached when the rotors have reached the position where the inlet arm on the lower rotor has reached the "corner" between the two bores opposite to that at which it is shown in Fig. 8 A. At this point most of the compressed air has been ejected *viâ* the delivery port, a small pocket, however, remaining in the space between the rotor arms. As the rotors continue to rotate from this position, the small pocket of compressed air referred to is released, and at once raises the pressure throughout the whole chamber to a value above that of the atmosphere. In other words, the chamber is now supercharged. At the commencement of the succeeding revolution practically the whole of this supercharged air is on the advancing or compression side of the rotor arms. This fact ensures that a full charge of new air is secured at every revolution, irrespective of the com-

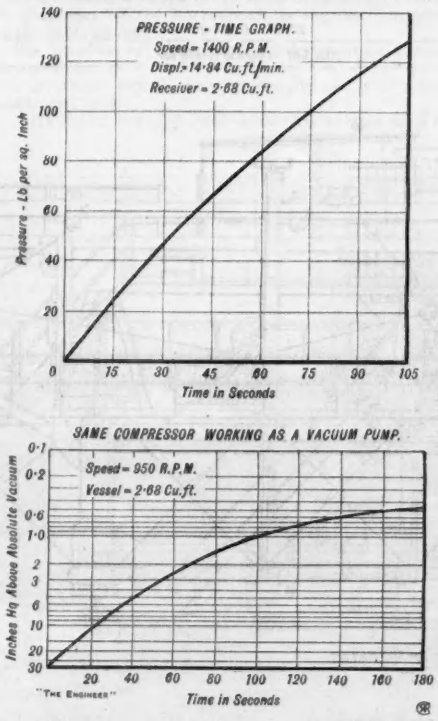


FIG. 9—PERFORMANCE CURVES OF NORTHEY PUMP

pression pressure. This supercharging effect is cumulative, so that the higher the delivery pressure attained the greater is the supercharging effect produced. Hence high pressures are quickly obtainable with high volumetric efficiency. The machines can be made to deliver fluid free from oil vapour when required, and in this way pumps for milk and other delicate liquids are constructed. When used as vacuum pumps, these machines have a high efficiency, as is shown on the lower curve in Fig. 9. Their compression efficiency is shown in the upper curve.

WESTINGHOUSE BRAKE AND SIGNAL COMPANY, LTD.

Since last year's exhibition very rapid advances have been made in the design of metal rectifiers, particularly those for the supply of current for electro-plating. Owing to their extensive use it has been possible to design a series of standard equipments with outputs suitable for electro-plating processes, and some of these standard rectifiers are exhibited by the Westinghouse Brake and Signal Company, Ltd., in addition to a representative range of rectifier charging equipments for battery service stations. Among these equipments is a multi-circuit outfit capable of giving the larger outputs now required for starter battery charging, &c. Like earlier sets of this kind, separate rectifiers and control gear are provided for each circuit.

FOSTER INSTRUMENT COMPANY, LTD.

Of the pyrometric equipments exhibited by the Foster Instrument Company, of Letchworth, Herts., the "Flexipush" automatic temperature controller shown in Fig. 11 is one of the most interesting and useful. The early experimental model of this patented controller was shown last year, and the present commercial model, which is suitable for wall mounting or flush panel mounting, is the outcome of the firm's experimental work. The instrument is of the indicating type, and with the makers standard recording controller it covers the full range of auto-

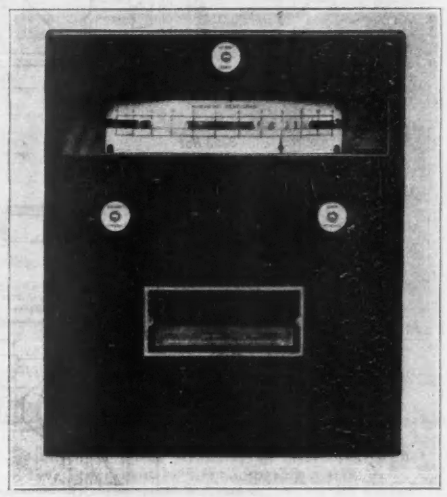


FIG. 11—TEMPERATURE CONTROLLER—FOSTER

matic temperature control equipment. The instrument can be used in conjunction with liquid-fuel-fired furnaces with the company's new "V" ported valves, designed so that equal increments of change in the valve position result in equal increments of change in the flow of fuel. Two of these valves can be coupled together and used on a forced draught furnace, and having been set to give a gas/air ratio will maintain that ratio within very close limits throughout the working range.

Another exhibit is the improved disappearing optical pyrometer (Fig. 10), incorporating the firm's lamp bridge unit system, in which the incandescent lamp and Wheatstone bridge are combined in one detachable and quickly replaceable unit which is interchangeable without the need for recalibrating the instrument. The complete assembly, comprising the lamp bridge unit, rheostat, telescope, and indicator, is mounted in a housing, and the open temperature scale is directly engraved in degrees Centigrade or Farenheit. Single and double-range instruments are available, the second range being obtained by the use of an absorption screen fitted inside the telescope body, and moved into or out of position by a small handle below the eyepiece. Generally, a small accumulator is supplied with the instrument, but when the use of an accumulator is inconvenient a dry battery is provided.

(To be continued.)

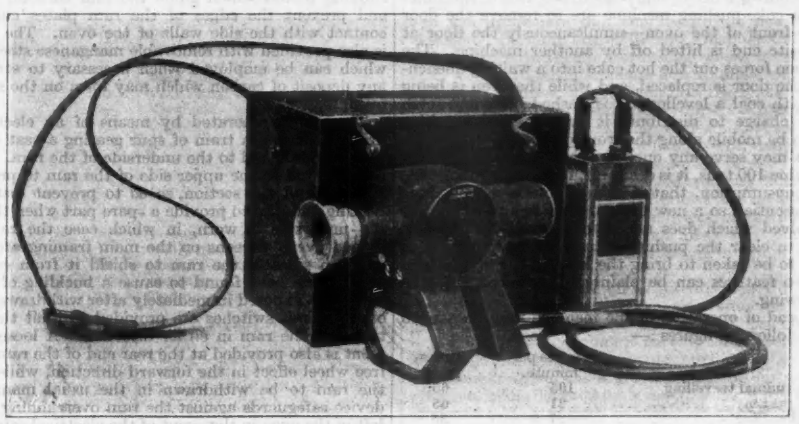
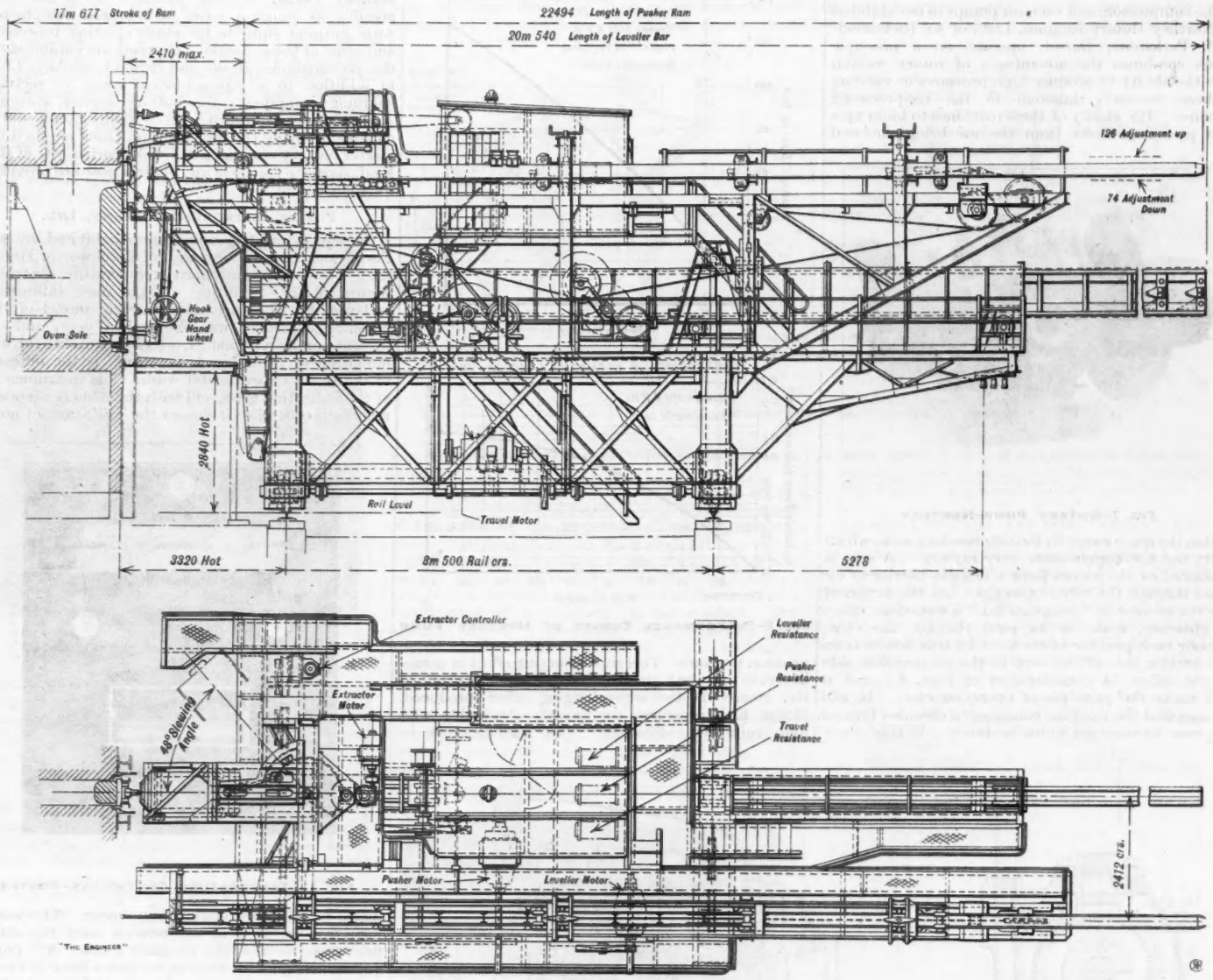


FIG. 10—OPTICAL PYROMETER—FOSTER

COKE PUSHER FOR COLLIERY IN HOLLAND

THE WELLMAN SMITH OWEN CORPORATION, WESTMINSTER, ENGINEERS



British Coke Oven Machinery in Holland.

IT is satisfying to find that an English firm is in a position to supply coke oven machinery to a Dutch colliery, for there appears to be a general impression that Continental engineers are pre-eminent in such business. But it is a fact, for the Wellman Smith Owen Corporation, of Victoria Station House, Victoria-street, Westminster, has recently supplied a fourth coke pusher and some other allied plant to the Maurits Mine plant of the Staatsmijnen, Lutterade, Holland. We reproduce a photograph of this latest machine, together with a line drawing showing its general arrangement.

The first three machines supplied to these works serve four banks of Coppee ovens totalling 264 ovens, while the new pusher is intended primarily to deal with two banks of 75 Otto ovens each. All the 414 ovens are in line, so one of the older machines has now been altered slightly, so that it can handle both the Becker doors of the Coppee ovens and the Woolf doors of the Otto set. The four machines are thus able to serve the whole range of ovens. They run on a track of 8½ m. gauge.

As, of course, most of our readers are aware, the functions of a coke-pushing machine are to remove the door from the front of the oven—simultaneously the door at the opposite end is lifted off by another machine. The pusher then forces out the hot coke into a waiting quenching car, the door is replaced, and while the oven is being refilled with coal a leveller bar is pushed back and forth over the charge to distribute it evenly. The machine must also be mobile along the front of the bank of ovens, so that it may serve any one. In view of the fact that it weighs some 100 tons, it is desirable, for the sake of electric current consumption, that it should not be moved more than is essential, so a new type of door removal gear has been evolved which does not involve moving the whole machine to clear the pushing ram from the door, but a step has to be taken to bring the leveller bar into action. These two features can be plainly discerned in the plan view drawing.

The speed of operation of the machine may be gauged from the following figures :—

	Metres per minute.	Horse-power.
Longitudinal travelling	105	65
Coke pushing	21	65
Coal levelling	27·5	35
Door extracting	—	7·5

The travelling motion consists of the electric motor carried on a structural seating in the lower portion of the main frame, and driving through a reduction of spur gearing and a horizontal cross shaft, on each end of which there is keyed a forged steel pinion. The teeth of these pinions engage with those of spur rings attached to both wheels of two of the four articulated bogies, one on each side of the machine. The arrangement of the driving and trailing wheels reduces the concentrated wheel loads and compensates for any inequalities in the track which may occur, owing to subsidence resulting from the fact that the plant is erected above the mine workings.

The main pusher gear, whose function it is to eject the charge of hot coke from the ovens, consists of a beam of box section built up of mild steel plates and sections, and carried by a series of cast steel rollers turning on pins supported by brackets fixed to the upper members of the main structure. At the forward end of the beam there is fixed the ram head, a heavy steel casting, the vertical face of which comes into contact with the hot coke in the oven. It is provided with manganese steel lateral rubbing plates, which guide the ram through the ovens and prevent the edges of the ram plates coming into contact with the side walls of the oven. The ram head is also provided with removable manganese steel scrapers, which can be employed when necessary to scrape away any deposit of carbon which may form on the roof of the oven.

The ram is operated by means of an electric motor driving through a train of spur gearing a cast steel rack, in segments, fixed to the underside of the ram. A similar rack is fixed to the upper side of the ram to preserve the symmetry of the section, so as to prevent distortion by heating and also to provide a spare part when the rack on the underside is worn, in which case the ram can be turned over. Screens on the main framing are provided on both sides of the ram to shield it from cold winds, which have been found to cause a buckling of the beam when it is exposed immediately after withdrawal from the oven. Limit switches are provided to limit the range of travel of the ram in either direction. A loose rack segment is also provided at the rear end of the ram to give a free wheel effect in the forward direction, whilst enabling the ram to be withdrawn in the usual manner. This device safeguards against the ram overrunning and being left in the oven in the event of the electrical safety devices failing for any reason.

The coal-levelling gear consists of a leveller bar, built up of mild steel plates, supported on cast steel rollers turning on pins fixed in a structural steel frame, the height of which can be varied to suit the leveller bar openings in the oven doors. The section of the leveller bar is such as to give a minimum of deflection when fully extended and to offer the least restriction to the flow of coal during the action of levelling which is effected by the reciprocating motion of the bar during the latter part of the oven filling operation. The movement of the bar is effected by means of two flexible steel wire ropes, one end of each being anchored to the bar while the other ends are fixed to a grooved rope drum driven by an electric motor through spur gearing. One rope winds on to the drum, while the other unwinds according to the direction of the motion. The ropes pass over large sheaves fixed at the ends of the supporting structure and the driving winch is so arranged that there are no reverse bends in the ropes which would reduce their useful life. The tension in the ropes is maintained constant by an automatic take-up gear. The reciprocating motion is obtained by the operator of the machine reversing the controller and regulating at the same time the length of stroke and speed of travel of the bar to suit the conditions. Access to the ovens for levelling by the bar is obtained through a small opening in the upper part of the main oven door, as may be seen on reference to the drawing. The cover to this door is removed as soon as the machine is placed with the leveller bar in line with the opening, by means of a simple hook and lever gear operated by the driver from his cabin without leaving the driving position. The leveller bar is provided with overwinding switches limiting its maximum travel in each direction.

Spillages of coal brought out by the leveller bar during its withdrawal from the oven are collected in a steel hopper in the front of the main framework, and provided with an inclined chute pivoted to the top of the hopper, which is automatically moved to and from the oven by the movement of the bar itself. These spillages are taken away at ground level at convenient intervals.

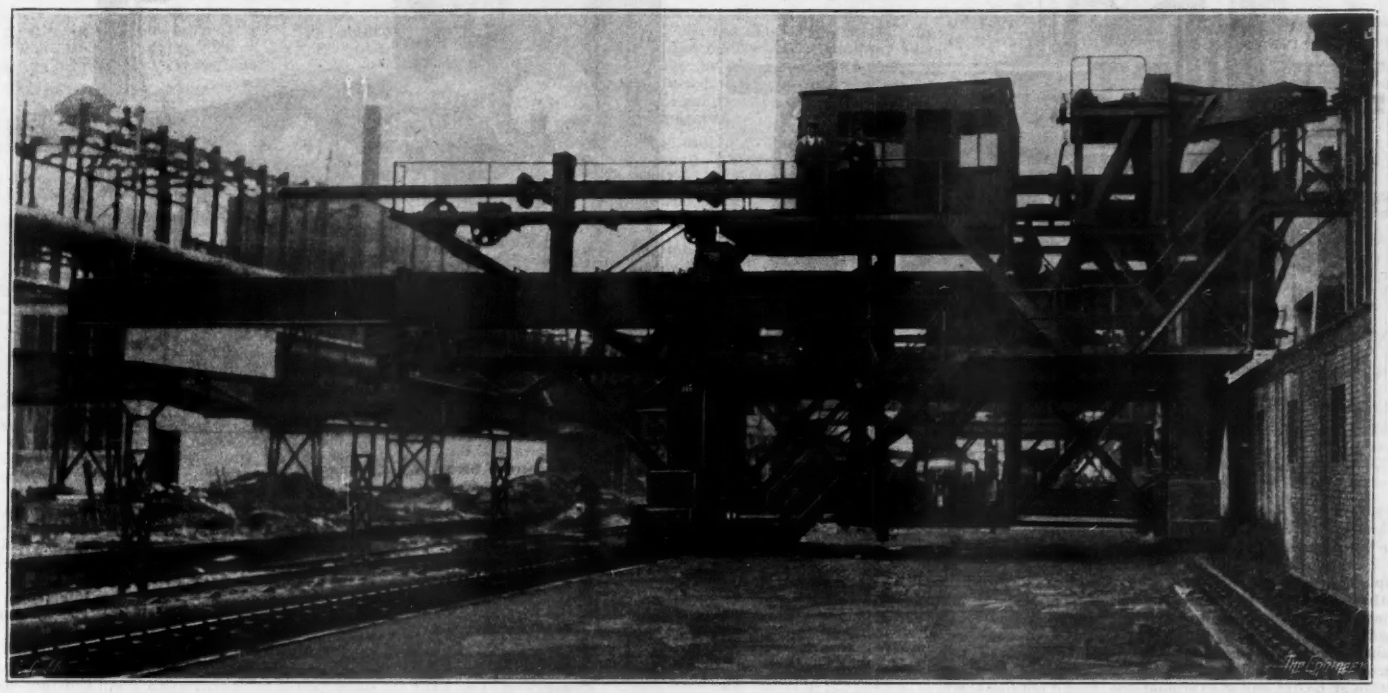
The oven doors, which are of the "Woolf" metallic sealing type, are removed and replaced by an extractor gear of the Wellman-Stockdale patented type, with combined racking and slewing motions driven by one motor. The racking trolley is provided with a dependent mast carrying the hand-operated hook gear and an adjustable buffer. The trolley is carried on four wheels running in a pivoted slewing frame operated by means of a fixed cam plate, a horizontal toothed segment and a connecting-rod. The sequence of operations is such that first a straight pull back motion is imparted to the trolley, withdrawing the door clear of the oven buckstays, and, secondly, the slewing frame and trolley are rotated through an angle of about 45 deg. clear of the path of the pusher ram. The door extractor gear is placed in line with the main

pusher ram, so that any given door may be removed, the oven pushed and the door replaced at one setting of the machine, thus simplifying considerably its operation and economising the current used in travelling the machine. The slewing extractor gear has the further advantage that it enables the door when removed to be rotated clear of all obstructions for the cleaning of the seals which is a great convenience, particularly in the case of the very high ovens now being constructed.

Special attention has been paid in the design of the machine to the provision of stairways and platforms giving the driver access to all parts of the machine directly from the cabin, facilitating in this way the various operations which he has to effect in the course of his service, as well as the lubrication and maintenance of the working parts.

The cabin, which is spacious and well lighted, is divided into two compartments, the front one, being fitted with glazed windows and doors, constituting the drivers' control position and having installed therein the main control panel, controllers, and travelling foot brake; the rear compartment is separated from the front by a fire-proof partition, and houses the starting and speed-regulating resistances.

In addition to the combined coke pushing, coal levelling, and door extractor machines, the Wellman Smith Owen Engineering Corporation, Ltd., has also supplied for service at the plant combined coke guide and door extractor machines, coal-charging larries and coke quenching cars, together with special apparatus for handling and storing the spare pusher rams and leveller bars in the space beneath the coal tower.



COKE PUSHER INSTALLED AT A COLLIERY IN HOLLAND

Silencers on Road Drills.*

DURING the repaving of Wilton-road in October last opportunity was taken to carry out a further test under the direction of the City Engineer of road drills fitted with silencers. Nine makers were each invited to bring two drills fitted with their silencers and the contractors for the paving works supplied unsilenced drills. In order that the relative loudness of the noises emitted by the ten pairs of drills should be scientifically recorded we invited and received the valuable assistance of the National Physical Laboratory and have received a report from its Director on the measured results. As this report is lengthy we submit extracts only from it with the permission of the Director.

EXTRACTS FROM REPORT (S.310) OF NATIONAL PHYSICAL LABORATORY.

Noise Tests.—The various pairs of silenced drills were driven in turn from a common air reservoir served by a battery of four distant compressors. The equivalent loudness of the noise from each pair of drills was measured by means of an objective noise meter which consisted of a calibrated microphone in conjunction with an electrical amplifier and indicating device designed to simulate the ear under appropriate conditions of loudness. Preliminary measurements showed that extraneous noises, including the noise arising from the compressors, were insufficient near the microphone to cause appreciable interference with the measurements of the noises emitted by the drills. The equivalent loudness of the noise of each pair of drills, as measured by the microphone, is expressed in phons in the table above.

Type of pneumatic drill.	Equivalent loudness of noise at 24ft. distance. (Objective meter.) Phons.
Unsilenced drills	103* (average)
Silenced drills—	
No. 1	102
No. 7	100
No. 2	96 to 98
No. 3	
No. 4	
No. 5	
No. 6	
No. 8	
No. 9	

* Average of results varying from 101 to 105.

The conclusions which may be drawn from the test appear to be :—

(1) Drills No. 1 were practically as loud as the unsilenced drills.

(2) Drills Nos. 2–9 were somewhat quieter than the unsilenced drills and, except perhaps No. 7, were of approximately equal loudness.

Extract from Supplementary Remarks by National Physical Laboratory.—Our instruments showed that the best of the silencers gave a noise reduction of about 7 phons, an improvement which is of the order that would be observed on doubling one's distance from the unsilenced drill in open conditions. A person hearing the silenced and unsilenced alternately might subjectively assess the noise reduction to be greater than our figures suggest, whereas another hearing them separately on different days would be quite unable to say whether the silencers effected any improvement at all. The fact is that at these loudness levels 7 phons is an appreciable improvement, bringing the noise nearer to that of general traffic noises in busy streets (say, 80 phons). However, even the silenced drills are as loud as the noisiest traffic and could not yet be regarded as unlikely to be objectionable to persons in the vicinity. One would expect the range of objectionableness, however, to be less than that of unsilenced drills so that the silencers would bring relief at the outskirts of the area normally subjected to undue noise.

EXTRACTS FROM REPORT OF CITY ENGINEER.

Efficiency Test.—In assessing the benefit derived from the use of silencers the question of loss of efficiency due to their use must be taken into account, as if the noise is reduced by only a few phons and efficiency is at the same time equally reduced, additional drills have to be employed and the reduction in noise is nullified. An efficiency test was therefore carried out with the above-mentioned drills. Equal areas of 12½ square yards of concrete (3 to 1 float) were allotted to each of the demonstrators. The result of the test was as follows :—

Type of pneumatic drill.	Time taken for unit area broken out.	Condition of concrete.	Remarks.
	Min.		
Unsilenced drills	75	Very hard	—
Silenced drills—			
No. 1	78	Very hard	—
No. 2	110	Very hard	—
No. 3	50	Very soft	Further ½ unit area of very hard concrete broken out in 20 min. equals 80 min. per unit
No. 4	90	Varied — generally hard	—
No. 5	70	Varied — generally hard	—
No. 6	68	Medium hardness	Silencer froze
No. 7	81	Medium hardness	Silencers froze
No. 8	68	Varied — generally hard	—
No. 9	120	Varied	—

Owing to the difficulty in hardness of the concrete it is difficult to draw precise conclusions from the foregoing table, but in the case of "silenced" drills Nos. 1, 3, 5, 6, 7, and 8 it would not appear that there was any marked diminution in efficiency as compared with the unsilenced drills. It should, however, be borne in mind that individual tests on small areas of old concrete of varying degrees of hardness are not conclusive evidence regarding efficiency and the general opinion of contractors hitherto has been that the use of silencers does in fact reduce efficiency.

CONCLUSIONS.

Although the amount of noise reduction by use of silencers is still somewhat meagre, it is, we think, gratifying evidence of progress made that a number of the machines included in the test secured that reduction without loss of efficiency. It must, however, be remembered that the concrete broken out by the competing machines varied in consistency, and we think in fairness to the makers that definite conclusions should not be drawn from the result of this one test. The importance of the subject, however, induces us to report to the Council in the hope that makers of silencers will continue their efforts in the perfecting of a silencer which will give a greater measure of relief from noise whilst retaining undiminished efficiency. We propose to give makers an opportunity in the course of the next twelve months to give a further demonstration of their machines, and in the meantime we shall consider the advisability of laying a special area of concrete for the purpose in order to ensure precisely similar conditions for all competitors.

* Extract from report of Works Committee to the Westminster City Council on January 23rd, 1936.

Old Centralians' Ideas on Education

(By an Old Centralian.)

THE idea which seems to have come into being about the time, last Spring, when the Central Technical College celebrated its jubilee, that the procedure of teaching there might well come under review, has in the interval gained considerable impetus. The Old Students' informal luncheon parties, together with some other more serious meetings, have provided opportunities for students, professors, and others to put forward their ideas, and although nothing very definite has yet been evolved, a considerable fund of opinion is accumulating, and it appears appropriate to give a brief sketch of the remarks made at the last meeting at the Imperial College Union.

First, it should be pointed out that this movement has not developed out of a sense of dissatisfaction with the College, but rather from a hope that it may be steered back again into something like the course on which it started. For anyone who attended the jubilee celebrations after having been at the College forty or fifty years ago will appreciate that the Institution has completely changed. Budding out of the old Finsbury College, with a group of enthusiastic professors, whose great *forte* was their ability to teach students how to make the utmost of their own abilities, to get them into the habit of thinking for themselves, and incidentally impart a groundwork of fundamental knowledge, the College appears to be a factory for producing more or less juvenile engineers and a group of research workers without masters.

It is the hope of some of the old students, headed by our veteran Dr. Armstrong, to consider some reversion to the older form of teaching. Nevertheless, at the meeting just referred to some very divergent ideas were put forward, and it will require a lot more discussion before a coherent policy can be formulated.

The meeting was held under the presidency of Sir Alfred Chatterton, one of the very early students (1885–87), who pointed out that the Central had lost some of its individuality in becoming a part of the Imperial College, and undertaking to train its students for the London B.Sc. He thought there was a grave danger of our educational resources being devoted too much to the training of average students to the neglect of those of greater ability, and suggested raising the standard for admission. He appre-

ciated the financial implications which such a policy would involve, but thought that quality, not quantity, should be the aim.

Mr. Herbert A. Humphrey, a contemporary of Sir Alfred, who has been intimately concerned with the Billingham works of I.C.I. in a consulting capacity, summarised a paper he had prepared in which he eulogised the late Professor Perry on his faculty of teaching by lecturing, and urged that professors should be appointed primarily on account of their ability to teach. Among the subjects taught at the College, he gave pride of place to mathematics as a course of mind training, and an implement for attacking all the complicated problems with which the progress of science and technology simply bristle. He also thought that chemistry and metallurgy should occupy more prominent places in an engineer's training. He stressed the value of the quality of self-reliance and the ability to judge the character of others. Although he did well at examinations, he did not like them, and found them restrictive.

Mr. L. St. L. Pendred, who joined the College a year later than Mr. Humphrey, but had the advantage of studying at both the Central and Finsbury—he has said that he greatly preferred the latter—cheerfully damned everything. He suggested that a new curriculum should be drawn up by a Board of Engineers who had nothing to do with the art and practice of education, and would start by blowing up the present regime, with its degree system and co-related examinations, libraries of text-books, and the College workshops. The study of mathematics would probably be curbed, for, as every engineer knows, 90 per cent. of his brethren make very little use of mathematics in the course of their daily duties. Arithmetic and algebra were generally sufficient so long as there was about 10 per cent. of mathematicians in the profession. It was noticeable that of the sciences taught in the Central, those of chemistry and biology have and are showing more imagination than the others, yet in them mathematics occupies but little of the curriculum.

Mr. Archibald Carmichael (1901–04) followed a rather unusual course, skipping the first year on the strength of having had four years' training in an engineering works, and thus, he says, unfortunately missed a year under Professor Armstrong, which inculcated the necessity of the power to think for oneself and to take nothing for granted. He said that, unless one is well grounded in mathematics, one can only do justice to oneself, quite apart from one's Professor, by exceedingly hard work and intense study. He considered that the question of costs should be brought more prominently to the notice of students, and that they should be encouraged to meet industrialists in order to broaden their outlook.

Mr. J. W. Voelcker (1920–22), concentrating on electrical engineering, hinted on the desirability of greater specialisation in education as in industry, but advocated a two-year course of fundamental theory and technology without professional segregation, leading to diploma standard; then a third year, according to profession, leading to a degree, or a co-operative course giving alternate college and works experience.

Mr. A. J. Anido (1907–09) was chiefly concerned with the passing of examinations, and suggested some alterations in the term time-tables which would bring the students more freshly to the subjects; and Mr. Kenneth Chatterton (1924–27) lauded the value of mathematics, and asked for more attention to costing, business methods, and the general financial side of engineering.

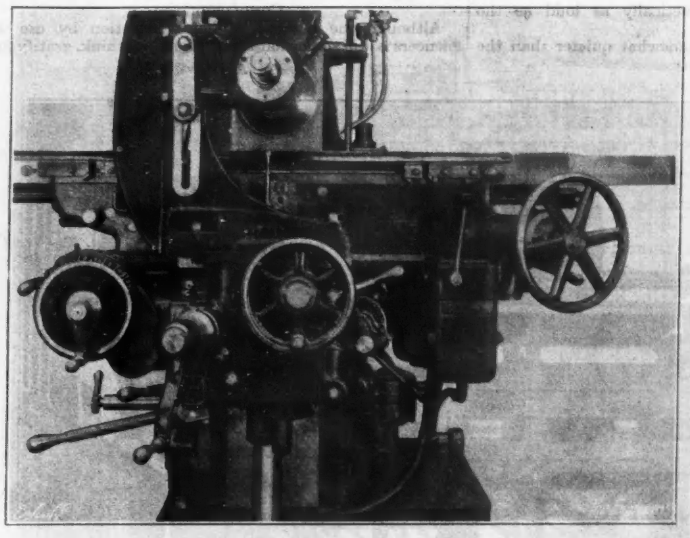
Dr. Armstrong, who opened the discussion, said that teachers could not be appointed; they were artists and accidents of time and place. The destruction of the Finsbury system at the Central in 1912 was a crime against Society. The step was taken without consulting the teachers of the College or accounting its influence. There was only one remedy: to make the College once more a self-contained efficiency unit.

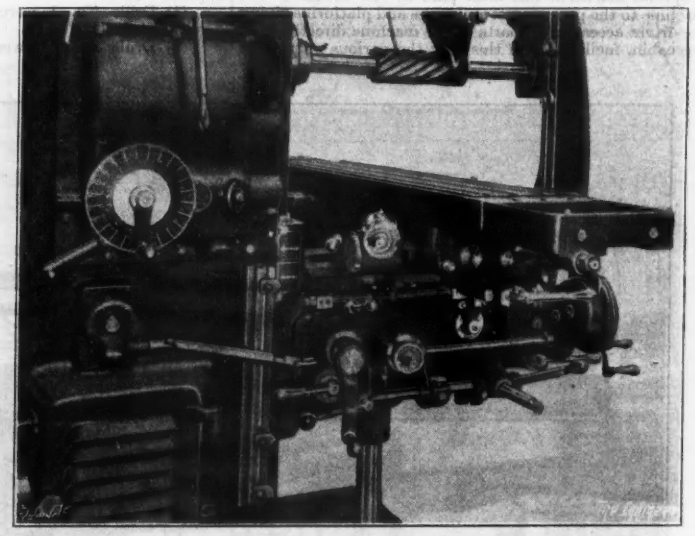
Professor Fortescue (Dean of the City and Guilds College) gave an interesting little discourse on the character of students, pointing out that most of them wanted the incentive of some real accomplishment to encourage them in their studies. The "jack-of-all-trades" engineer, he said, learned to be able to deal with any emergency he might meet *after* he left the College, not whilst he was there; for were not all agreed that the duty of the College was to develop a man so that he might make himself into a man later?

A complete report of the meeting is given in the December number of "The Central," the journal of the Old Centralians, and it is hoped that others than old students will read it.

Dual Control Plain Milling Machine

THE new horizontal milling machine illustrated in the accompanying engravings and made by Alfred Herbert, Ltd., of Coventry, has been designed to be capable of a high output with sustained accuracy. To effect this purpose, it has been provided with an unusually large range of spindle speeds and feeds with automatic feed to the three motions of the table, and complete control from both back and front of the knee. The illustrations show well the general design of the machine to which little more reference need be made than to observe that the spindle and all the driving shafts are mounted in ball bearings and that the machine is a self-contained unit with its own drive from a motor mounted on a hinged base, within the column, and transmitting the power through tex ropes. The driving box makes available twenty-four spindle speeds from 25 to 1290 r.p.m. Speed changes, which are made through cam-operated gears sliding on multi-splined shafts, are brought into operation by the hand crank on a dial which has large easily read figures. The dial can be rotated in either direction. The starting lever is situated on the left-hand side of the column. In the beginning of its motion a brake is released and further movement operates a switch to start the motor. In changing the spindle speeds it is advisable, so the makers state, to move the lever to the half-way position where the motor is switched off, but the brake not applied.



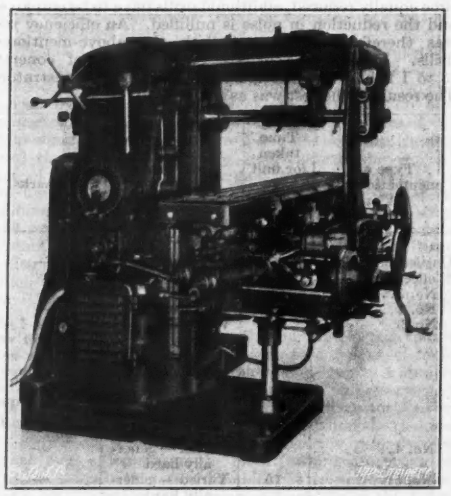


DETAILED VIEWS OF DUAL CONTROL PLAIN MILLING MACHINE SHOWING CONTROLS

Longitudinal feed	36in.
Transverse feed	12in.
Maximum distance from centre of spindle to table	19in.
Working surface of table	58in. by 12in.
Number and width of tee slots in table	Three, ⅝in.
Maximum width from face of column to arm brace	28½in.
Centre of spindle to arm	6½in.
Horse-power of main motor	7½
Speed of motor	1450 r.p.m.
Number of spindle speeds	24
Range of spindle speeds	25 to 1290 r.p.m
Number of automatic feeds	24
Range of automatic feeds, inches per minute	¼in. to 60in.

Principal Dimensions with Attachments.

Vertical milling attachment:	
Distance from face of column to centre of spindle	14in.
Maximum distance from spindle nose to top of table	17⅛in.
Circular table with automatic feed:	
Diameter	16in.
Height	6⅛in.
Universal milling attachment:	
Distance from face of column to centre of spindle when vertical	12 $\frac{13}{16}$ in.
Maximum distance from spindle nose to table with spindle vertical	18in.
Slotting attachment:	
Distance from face of column to face of tool holder	12 $\frac{13}{16}$ in.
Maximum distance from tool holder at bottom of stroke to table	13in.
Length of stroke	0in.–4in.



DUAL CONTROL PLAIN MILLING MACHINE

The feed-box is driven by spur gears from the first shaft of the driving box. It gives twenty-four rates of automatic feed from ¼in. to 60in. per minute, all of which are independent of the spindle speed. Feed changes are effected in a manner similar to that of the speed changes on a separate dial. The various feeds are engaged to the table by levers on the front of the saddle and knee, which move in the direction it is desired the table shall travel. For the quick power table traverse a small constant-speed motor is carried on the right-hand side of the knee. Another electric motor drives a centrifugal pump delivering cutting compound from the sump in the base. Telescopic piping returns the fluid to the sump.

As to the general design of the machine the name Herbert carries with it a reputation for excellent workmanship and attention to detail, while the illustrations reproduced with this article will be sufficient to indicate most of the points of interest. It is worth noting that the spindle nose is standard, and has a taper hole, and that the spindle is bored through and provided with a draw-bolt and an adapter for use with arbors, cutters, and collets. The knee is clamped to the column by the movement of the taper gib endwise by rack and pinion from a powerful lever. All gears, bearings, and internal mechanisms are continuously flooded with filtered oil, the flow of which can be observed in a glass indicator. The machine can be supplied with a circular table, and among the attachments there are vertical and universal millers. The principal dimensions and other particulars of the machine are given in the accompanying table.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

TUNGSTEN FILAMENT LAMPS.

No. 161—1936. A revision of the specification for General Service Electric Lamps (B.S.S. No. 161) has just been issued. The only modification made to the text is the requirement that lamps shall be marked single coil or coiled coil, as required. The efficiency of the single coil filament lamps has been increased, and the schedule for coiled coil filament lamps, which was previously issued as an addendum, has been incorporated.

BITUMINOUS ROAD MIXTURES.

No. 598—1936. The Institution has recently published British Standard Methods for the Sampling and Examination of Bituminous Road Mixtures. These methods have been drawn up to provide a standard procedure for the examination of bituminous mixtures (asphalt and tar-macadam) used for road surfacing. Detailed procedures are laid down for the taking of samples, both before the mixtures are laid, and also from the finished road surface. The methods of examination cover a large majority of the methods used for the normal testing of road mixtures, including specific gravity, content of bituminous matter, water content and mineralogical identification of the aggregate.

Incorporated in the publication is a suggested form for a certificate of analysis which has been prepared, so that test results obtained by using the methods laid down may be tabulated in a uniform manner and facilitate comparison. This certificate has been drawn up so as to be equally suitable for the reporting of examination of asphalt mixtures or tar mixtures, and also for use both in works laboratories and by consulting analysts. This specification is published at 3s. 8d. post free.

Rail and Road.

THE Minister of Transport has approved a scheme for the widening of a length of the Harrow–Kingston road, at an estimated cost of £30,800.

DURING the first four weeks of this year 87 people were killed and 3562 injured in the streets of Greater London, as compared with 103 killed and 3718 injured for the corresponding period last year.

AN unusual accident occurred on the King's Cross–Peterborough section of the L.N.E.R. on Monday, February 3rd. The tire of one of the driving wheels of the train engine—it was double-headed—working the Harrogate–King's Cross afternoon train came off and derailed two of the wheels of the tender. There are only about half a dozen failures of engine wheel tires a year.

AT a meeting of the Manchester City Council on February 5th it was resolved that in view of the congestion of traffic and of the growth of street accidents, a special committee be appointed with powers to co-opt representatives of the railway and other transport and interested bodies to consider and report upon the question of an underground railway or an electric tube railway under the city.

IN *The Times* of February 8th, appeared a letter from Mr. G. H. Jack, a member of the Council for the Preservation of Rural England, in praise of the scheme of the Corporation of the City of Chester mentioned herein on February 7th for providing street traffic light signals that will provide for the increased carrying capacity of the Old River Dee Bridge without any widening or structural alterations.

IN the Annual Article "Railway Engineering in 1935," which appeared in our issue of January 17th, mention was made of work at Wyre Docks, Fleetwood, L.M.S.R. This includes six new coaling plants, which are fitted with electrically operated belt conveyors, capable of dealing with 20-ton wagons. They will replace the bunkering of trawlers by means of cranes and buckets. Following the introduction of the new appliances the L.M.S.R. will take over the whole of the work in connection with coal shipping, including trimming.

THE portion of the Mersey Railway between Green-lane, Tranmere, and the Birkenhead side of the river and James-street, Liverpool, was opened on February 1st, 1886—fifty years ago. It was extended to a low-level station under the Cheshire Lines Committee's Liverpool Central Station on January 11th, 1892. After having been worked by steam for nearly twenty-four years, powers were obtained in 1900 to operate it by electric traction, and conversion was completed on May 3rd, 1903. That was the first case of an English steam-worked railway being changed to electrical operation.

IT is announced that as a result of conferences between the Ministry of Transport and Local Authorities in the Metropolis, guard rails which fence off the footpaths from the road are almost certain to appear soon in busy places. It has been suggested that they should be erected, among other places, in Trafalgar Square and Oxford Circus, but a decision as to these has not been reached with the Local Authorities. Poplar and Stepney are other places that are under consideration. A very important point which is also being discussed is the removal of illuminated advertising signs which are likely to be confused with street traffic signals.

AT the Ministry of Transport inquiry into the Shrivenham accident two unusual causes of train delays that produced considerable disorganisation on the Great Western at Christmas were mentioned. One was that the threatened coal strike had put an abnormal amount of coal traffic on the line, and there was very great difficulty in shunting these coal trains for others to pass them. Another cause of dislocation was that, as related in our Annual Article "Railway Engineering in 1935," the company's big carriage sidings and train-marshalling yard at Old Oak Common are being reorganised and reconstructed. As an illustration of the delays to coal trains it may be remarked that the coal train concerned in the Shrivenham disaster had entered upon the second day of its journey from South Wales when it met with its accident.

THE Minister of Transport has accepted with great regret the resignation from the chairmanship of the Transport Advisory Council of the Right Hon. the Viscount Goschen, who, owing to increasing demands upon him in other directions, finds it impossible to continue to give the necessary time to the work of the Council. Mr. Hore-Belisha has appointed in his place the Right Hon. Sir Arthur Griffith-Boscawen. In view of the independent character of the appointment, Sir Arthur Griffith-Boscawen has divested himself of all financial and other similar interests in transport undertakings of every description. The change will take place on March 1st. Lord Goschen has been Chairman of the Transport Advisory Council since its appointment in February, 1934. Sir Arthur Griffith-Boscawen was Chairman of the Royal Commission on Transport, 1928–30, on whose recommendation the Transport Advisory Council was constituted.

A SPECIAL exhibition is being held at the Science Museum until April 30th, to commemorate the opening of the London and Greenwich Railway, which is notable as being the first railway in London. The railway was projected in 1832 by Mr. G. Walter and authorised in May, 1833, with a capital of £400,000; further Acts to increase the capital were obtained in 1835 and 1837. The original survey was made by Mr. F. Giles and Lieut.-Colonel G. T. Landmann, the company's engineer, designed and carried out all the works, a remarkable feature being that the line was carried throughout on a brick viaduct. Construction commenced in April, 1834, and the part of the line between Spa-road and Deptford was opened to the public on February 8th, 1836. The extension to London Bridge was opened on December 14th, 1836, while the Greenwich end was completed in December, 1838; Deptford then became the only intermediate station. The exhibition comprises prints, books, tickets, medals, and other relics relating to the line, lent for the occasion by the Southern Railway Company, Mr. C. F. Dendy Marshall, Mr. J. Phillimore, and others.

Miscellanea.

IT is officially announced that there were thirty-seven killed as a result of the recent explosion in the Loyabad Colliery at Jharia, in India.

AFTER descending Gresford Colliery, mining experts decided that it would not yet be safe to break the seals in the Dennis area where the bodies of the explosion victims are entombed.

WHAT is believed to be the first electrical emergency lighting system to be adopted by Trinity House for a lighthouse is the installation of equipment ordered from the Chloride Electrical Storage Company, Ltd., for the Withernsea Lighthouse, on the Yorkshire coast. In the event of a failure in the main electricity supply this system enables a storage battery, controlled from a specially designed switchboard, to provide instantaneously and automatically current sufficient to maintain the light until the main supply is restored.

MOST of the elemental sulphur of the world is now obtained from the sulphur "domes" of Texas and Louisiana, from which over 1,500,000 tons are obtained yearly. Hot water is forced down into the deposits, where it melts the sulphur, which is then raised as 99·5 per cent. pure liquid by means of air lifts. It solidifies in enormous bins, on cooling, and when broken up is ready for shipment. Individual bins may contain 100,000 tons or more at one time. Sulphur domes are not innumerable, and will some day be exhausted, but known reserves of sulphur in these domes are greater now than they were ten years ago.

THE production of direct-flow, high-pressure boilers on Professor L. K. Ramzin's system is being undertaken by the Lenin Nievski Machine Building Plant, Leningrad. Five stationary boilers of this type are to be made this year. One of these boilers—an oil-burning unit with a maximum capacity of 200 tons of steam per hour at 35 atmospheres pressure—will be installed in the power station at Grozneft. Two boilers of the same capacity, but using coal dust for fuel, will be installed in the Magnitogorsk Metallurgical Plant. The other two boilers will carry a pressure of 140 atmospheres, and will have a capacity of 200 tons of steam per hour. They are intended for the Molotov Automobile Works in Gorki.

THIN films of metals deposited on glass by volatilisation *in vacuo* were used by P. J. Haringhuizen and D. A. Was in studying the deterioration of insulating oils in contact with tin, copper, and lead. The results of the researches carried out on behalf of the International Tin Research and Development Council have been issued as the Council's Technical Publication Series A, No. 29. The amount of sludge formed and the darkening of the oil after 1000 hours at 90 deg. Cent. were quantitatively determined. The deterioration shown by these tests was less with tin than with lead, copper, and the blank experiments, from which it appears probable that tin may perhaps act as an anti-oxidant, as it was shown to do in lubricating oils by Mardles. Tests made every 200 hours over a period of 1600 hours showed that the ultimate increase in acidity was least in the oil in contact with tin.

AN extract in the *Journal* of the Institution of Automobile Engineers deals with the electrolytic cleaning of exhaust valves. In this process the iron article is made the cathode in a bath of fused caustic soda-sodium carbonate mixture and carbon deposits are removed during electrolysis. The process has been developed for the cleaning of exhaust valves, but functions equally well with scaling specimens, and in removing forging scale. The valve is first freed from excess of oily material by washing or heating, then placed in the melt of 60 parts caustic soda and 40 parts sodium carbonate, and a current of about 6 ampères at 6 volts (for valves from 1¼in. to 3in. diameter) passed, the current being continued for two to five minutes. After removing from the bath, the valve is placed in water and solid caustic soda dissolved off, after which any remaining deposit is removed by a brass wire brush. Tests made on polished specimens have shown that the loss of metal during the process is negligible. Throughout the process precautions should be taken against splashing by caustic soda; also valves with hollow stems are apt to blow out driven-in plugs.

IN a lecture to the Junior Institution of Engineers on January 24th, Mr. H. G. R. Stevenson related some of his experiences on the oilfields in Sarawak. Of the two methods employed for drilling, the older or percussion method has largely disappeared in favour of the rotary drill driven either by steam or oil. The immense depth of some of the bores, which may reach 7 miles, and the difference in resistance to penetration of the various strata, make it almost impossible to keep the bore vertical, and it was stated that a fortune awaited anyone who could devise some means of ascertaining exactly how the bore was deviating from the vertical. The bore decreases in diameter as it descends. It may commence with a diameter of 4ft. and continue at this width until the first hard stratum is met with, being then lined with steel piping plugged at the bottom with cement run in by gravity or under pressure. The hard stratum is then penetrated by a gear drill and continued at a smaller diameter to the next hard layer, smaller tubes lining each successive reduced diameter until at about 7 or 8 miles deep the tubes may be only 4in. or 6in diameter. The drill shaft is hollow, in lengths of 20ft., each length being fixed to the next by a coned and left-hand screwed joint. The weight of the drill and a string of tubes is about 60 tons per mile. At the drill point are two holes through which a mixture of mud, cement, and water escapes under pressure when pumped down the hollow drill tubes. This muddy paste acts as a lubricant and also elevates the material removed by the drill to the surface. It also closes up the pores in the wall of the drilled hole, and is of great value when bringing the well into use. Although the oil when reached may be at a pressure of 2000 lb. per square inch, the hole being full of the mud compound, the oil cannot escape before it is wanted. By lowering the specific gravity of the mixture by pumping in water a point is reached at which the weight of the column is overbalanced by the pressure and the oil commences to flow.

Air and Water.

A PETITION has been presented by the Royal Mail Steamship Company for the voluntary winding up of the company.

ALTERATIONS have been made to the L.N.E.R. Harwich–Antwerp steamers whereby the accommodation for motor cars has been nearly doubled.

THE two pilots were injured and six passengers shaken when the Imperial Airways air liner "Artemis" crashed when leaving the Pietersburg aerodrome for Johannesburg.

A NOTE in *Flight* says that a glass bomb has been introduced to enable pilots flying over water to measure the speed and drift of their machines. The bomb spreads a film of aluminium powder on the sea.

IT has been decided by the Commonwealth and Dominion Line that the company will in future be known as Port Line. "The Commonwealth and Dominion Line, Ltd.," will remain the registered title of the company.

IT is understood that the Cunard-White Star Line has under consideration the building of a sister ship to the "Queen Mary." The inquiries are of a preliminary character and are for a similar but slightly smaller vessel.

A NEW record has been established by Flight Lieutenant Rose, who has flown from Lympne to Cape Town in 3 days 17 h. 38 min. in a "Miles Falcon" monoplane. His route was *vid* Malta, Khartoum, Kisumu, and Salisbury.

AN attempt is being made by Flight Lieutenant David Llewellyn to fly from Lympne to Cape Town in a 40 h.p. monoplane. The machine has a cruising speed of 85 m.p.h., and carries 27 gallons of petrol giving it a range of some 650 miles.

ACCORDING to a statement by Major R. H. S. Mealing before the Aerodrome Owners Association, the average cost of a municipal aerodrome may exceed £100,000. This sum included the cost of preparing the land and provision of buildings and facilities.

WHILST carrying out manœuvres over Munich two German Air Force machines collided and one of them fell into a city street, causing the death of four pedestrians and injuring a number of others. Both the pilots took to their parachutes and landed uninjured.

As a result of the shipyard workers' strike at St. Nazaire, the construction of the battle-cruiser "Strasbourg" and the cruiser "Georges Leygues" were held up, and the strike spread to Le Havre, where alterations to the "Normandie" are in progress. The strike has now ended.

A NEW air service between this country and Sweden has been inaugurated by British Continental Airways. The route, which is from Croydon to Malmo *vid* Amsterdam, Hamburg, and Copenhagen, will be extended to Stockholm when the aerodrome under construction there is completed.

A JAPANESE firm is reported to be attempting to build a 15,000-ton whaling vessel in the short period of five months. This vessel, it is stated, must leave Japan by October 1st next to be in time for the Antarctic whaling season. The keel is to be laid about the middle of April, and the cost of the ship is to be some £4,750,000.

IT is announced that the French Minister for the Mercantile Marine is making arrangements for the construction of a new "L'Atlantique" in the Penhoet dockyards. The new "L'Atlantique" will have a tonnage of 30,000, and will cost approximately £2,570,000. The construction of the liner will, it is estimated, employ 4000 men for 2½ years.

REPORTS state that Italian tramp ships, returning empty after taking war supplies to Eritrea or Somaliland, are now competing for ordinary commercial cargoes in the London freight market. Previously, these vessels, after discharging their cargoes, returned to Italy in ballast. Now they are being chartered to carry goods from India and Indo-China to Europe, principally France.

THE proposal by the Indian Government that the Indian National Airways should be subsidised has been rejected by the standing Finance Committee of the Legislative Assembly. The Government proposal was that a grant of £8300 should be made in the coming year to enable the company to continue its Karachi–Lahore service and expand its headquarters in Delhi to meet the possible needs of the Empire air mail scheme in 1937.

THE Gdynia America liner "Pulaski," for years in service between New York and the Baltic, is being completely renovated in preparation for the inauguration of a new service between Poland and South America on February 28th. The "Pulaski" and the "Kosciuszko" were replaced on the New York route by the new motor liner "Pilsudski" and her sister ship, the "Batory," due to make her maiden voyage to New York in May, are to be used for the service.

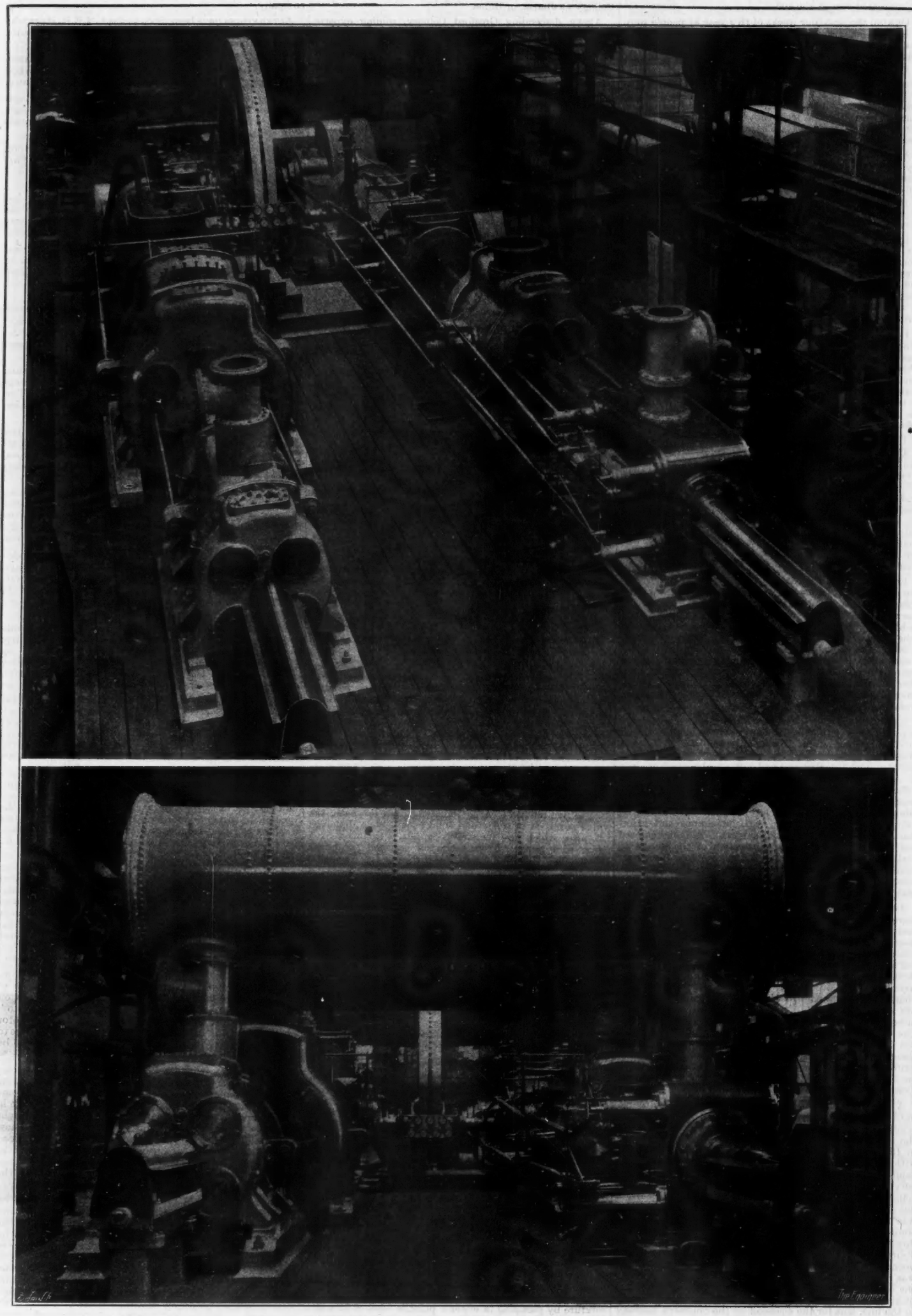
ACCORDING to the *Western Morning News* the Exeter City Council is to let its proposed municipal aerodrome to Mr. Whitney Straight, who stated that the aerodrome is to become one of a chain of five others to be set up in various parts of the country. Mr. Whitney Straight already operates an aerodrome at Ramsgate, and is now negotiating for a number of others, including the proposed one at Exeter. The chain of air centres is intended to provide air taxi facilities, together with special amenities for air travellers and others engaged in flying at the various aviation centres.

AN important shipbuilding order has been secured by William Denny and Brothers, of Leven Shipyard, Dumbarton, for a 9000 ton cargo and passenger vessel. The vessel, which will be of the single-screw type driven by turbines through single reduction gearing, is the order of F. Henderson and Co., of Glasgow, for their service to Burma. There is also the prospect of a Belgian order coming to the Clyde. Several West of Scotland shipbuilders have been invited to submit tenders for a passenger vessel for the Compagnie Maritime Belge of about 450ft. in length. Alternative designs of steam and Diesel machinery are also being invited.

DE-HUMIDIFIER AIR COMPRESSOR FOR SOUTH AFRICA

WALKER BROTHERS (WIGAN) LTD., ENGINEERS

(*For description see page 186.*)



The Engineer

FEBRUARY 14, 1936.

VOL. CLXI. No. 4179

Contents.

THE ENGINEER, February 14th, 1936. PAGE

A SEVEN-DAY JOURNAL ... 167
AMERICAN BEACH AND SHORE PROTECTION WORKS. No. V. (Illus.) ... 168
MANUFACTURED WEATHER IN THE TROPICS ... 170
THE BRITISH INDUSTRIES FAIR AT BIRMINGHAM. No. I. (Illus.) 171
BRITISH COKE OVEN MACHINERY IN HOLLAND. (Illus.) ... 174
SILENCERS ON ROAD DRILLS ... 175
OLD CENTRALIANS' IDEAS ON EDUCATION ... 175
DUAL CONTROL PLAIN MILLING MACHINE. (Illus.) ... 176
BRITISH STANDARDS INSTITUTION ... 176
RAIL AND ROAD ... 177
MISCELLANEA ... 177
AIR AND WATER ... 177
LEADING ARTICLES—
Mathematics and Engineers ... 179
The Silencing of Road Drills ... 179
LITERATURE ... 180
BOOKS RECEIVED ... 180
SIXTY YEARS AGO ... 180
RECENT PRACTICE IN HYDRO-ELECTRIC POWER DEVELOPMENT. No. I. (Illus.) ... 181
LETTERS TO THE EDITOR—
Incentives and the Practical Man ... 182
Watt and the Glasgow Hammermen ... 182
Mechanical Stoking for Scotch Marine Boilers ... 183
Competition of Costing ... 183
A VISIT TO THE BENJAMIN ELECTRIC COMPANY'S WORKS. (Illus.) 183
A TWO-STAGE AIR COMPRESSOR. (Illus.) ... 184
A SMALL PORTABLE SUB-STATION. (Illus.) ... 184
A NEW IMPACT BREAKER AND GRANULATOR. (Illus.) ... 185
ENGLISH INSULATION IN HOLLAND. (Illus.) ... 185
A LARGE DE-HUMIDIFIER AIR COMPRESSOR. (Illus.) ... 186
ELECTRICAL EQUIPMENT AT THE NATIONAL COKE AND OIL COMPANY'S WORKS. (Illus.) ... 187
CONTRACTS AND ORDERS ... 188
SOUTH AFRICAN ENGINEERING NOTES ... 188
MARKETS, NOTES AND NEWS ... 189
CURRENT PRICES FOR METALS AND FUELS ... 190
FRENCH ENGINEERING NOTES ... 191
BRITISH PATENT SPECIFICATIONS. (Illus.) ... 191
FORTHCOMING ENGAGEMENTS ... 192
PERSONAL AND BUSINESS ANNOUNCEMENTS ... 192

EIGHT-PAGE SUPPLEMENT—THE BRITISH INDUSTRIES FAIR AT BIRMINGHAM.

NOTICES TO READERS.

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CHANGES OF ADDRESS.

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MATHEMATICS AND ENGINEERS.

A FEW weeks ago we referred cautiously to a symposium and discussion on technical education which had taken place some weeks before at the City and Guilds (Engineering) College, S. Kensington. At the time of the debate it was more or less tacitly understood that it was being held *in camera*. Subsequently, the authors and speakers were asked if they would agree to publication of their papers and observations. Their consent having been secured, the symposium, somewhat condensed, has been printed in the December issue of *The Central*. The meeting had the merit of being called by Old Centralians, and only past and present students and the staff of the College were invited to be present. It was an admirable idea that the alumni of past years should look at the work of the College as it is being conducted to-day through the eye of experience and comment upon what they saw. The very fact that the conference was convened was an indication that the Old Centralians were not entirely satisfied with the work of the College, yet there was very little real criticism in the papers presented, or in the discussion, and what there was turned rather more on details of organisation than on the wider principles of technical education. That the debate will have any effect whatever upon the curriculum of the College we doubt greatly. Broadly speaking, it may be said that those who spoke for the staff showed but little sympathy with the virtual, if not real, criticism of the old students. This is quite understandable. It is not very long since the Governors of the College called a special committee of inquiry into the arrangement of the curricula of the three engineering departments. That committee met several times, examined the question from all points of view, and finally made certain recommendations. After such a special investigation it was hardly to be expected that the staff would regard with much sympathy criticism based on general rather than on precise data.

On another page we give a short summary of the papers. We do not propose to deal with the whole subject here, but select one point, and one only, on which there was difference of opinion. We refer to the position which mathematics occupies in the curricula of the "C. and G." and, we may add, in nearly all engineering schools. On the whole, we think it would be just to say that the speakers were not dissatisfied with the present arrangements, and one or two spoke of the value that mathematics had been to them. But one must expect mathematicians to speak well of mathematics. There is no question now, and there never can be any question, of the vast importance and value of mathematics to engineering in the hands of those who have an aptitude for it. On the other hand, there is no small doubt about the desirability of attempting to teach equal mathematics to all and sundry, and giving much weight to it in examinations. The fact cannot be gainsaid that only a very small proportion of those who follow engineering as a vocation really need an advanced knowledge of the science of figures. Since any curriculum must of necessity be limited in time and subjects, there is always the possibility that matter which would be of greater value to a greater number of engineers is being neglected in order to find a place for one which, by academic approval, rather than by common consent, has come to be accepted as an essential item in the education of engineers. Mathematics is like fiddling; it is the gift of a few. If all men were Kreislers it would be worth regarding the violin, as the piano once was, as an essential element of a polite education. Happily, Nature has reserved the catgut art to the few, and happily or unhappily, she has done the same with mathematics. If that were a real disability there would be very few engineers in the world and still fewer inventors. The plain fact is that the industry of engineering can get on quite well with a very small number of really expert mathematicians, just as the B.B.C. can get on with a very few first-class fiddlers.

We understand that there is some difference of opinion about this question of aptitude. The modern view appears to be that Art cannot be taught, and the professors in the life classes of to-day encourage their pupils to practice assiduously; but rarely instruct them. We know of professors who take the same view with regard to mathematics. They conceive that those students with a natural bent require little teaching, whilst those without it cannot be taught. But there is an opposite line of thought which avers that all normal human beings could be made mathematicians and that failure lies in the teacher and not in the student. That opens up too big a question to be discussed at the end of an article. It affects not only mathematics, but all other subjects of education. The real teacher is Heaven sent. He must be sought out with care and be remunerated highly. He should be the most precious thing in a school or university. Unfortunately, we know that he is not. Many men are teachers because they are incompetent to be anything else; many others are professors not because they have that rare art of invoking knowledge in others, but because they are distinguished for their own works. For ourselves, we doubt very greatly that mathematics can ever be a subject for the million, but we are certain that the greatest reform in that or in any other detail of school curricula would be the appointment only of men who were blessed with that rare and peculiar jewel, the power to infect other men with their knowledge and to encourage in them its greater growth.

The Silencing of Road Drills.

THE spring and summer months, when the chattering crash of the pneumatic road breaker will be heard in the streets of every city, are fast approaching once again. It has been claimed, even by engineers themselves, that nothing can be done to reduce this noise without a disproportionate loss in efficiency. For the noise arises not only from the blow of the hammer upon the tool, which might perhaps be dulled by the interposition of a hard rubber pad or other cushioning means, but also from the bark of the exhaust of highly compressed air from the cylinder. The fitting of a silencer, it is claimed, must increase the back pressure and so reduce the power of the tool while itself being liable to freeze up or, under the violent conditions of vibratory movement, to be broken or in other ways rendered inoperative.

Several firms have, however, made the attempt to reduce the noise, and we publish on another page an extract from a report of the Works Committee to the Council of the City of Westminster on comparative tests carried out during the re-paving of Wilton-road in October last. Nine pairs of silenced drills by different makers were used and compared with a pair of unsilenced drills. With the assistance of the National Physical Laboratory careful measurements of the noise produced were taken by the use of an objective noise meter of the kind which has an indicating device designed to simulate the ear. Results were hardly such as to give great encouragement. The silencers did, indeed, effect some improvement, but it was of so slight a degree that a person hearing the silenced and unsilenced drills on different days would have been unable to choose between them, although hearing them together he could have been in no doubt as to which was best. In figures, the unsilenced drill gave an equivalent loudness of noise at 24ft. distance of 103 phons, while the better silenced drills gave corresponding figures between 96 and 98 phons. In the matter of efficiency the tests were less conclusive. Each drill was required to break out a "unit" area of concrete and the time taken to perform the operation was measured. Unfortunately, the condition of the concrete varied from "Very Hard" to "Very Soft," so that comparison was largely vitiated by doubt as to the condition of the material dealt with. The figures, however, seem to lead to the conclusion that the silenced drills were at no marked disadvantage when compared with their unsilenced counterparts. The time taken by the unsilenced drill to break out $12\frac{1}{2}$ square yards was 75 minutes, and the material is stated to have been "Very Hard." While the times taken by the silenced tools varied from 120 minutes (Varied) and 110 minutes (Very Hard) as maxima to a general average value of about 75 minutes (Varied: Generally Hard or Medium). In two cases, it should be noted, the silencers froze. Though the improvement shown is, at best, a slight one, it should not be a matter for depression that it is no better. The attention of engineers has been directed attentively to the subject only for a short time and several possible courses of development remain open besides that of designing more efficient silencers alone. In a leader in our issue of October 9th, 1935, we inquired as to the necessity of breaking up at frequent intervals the expensive concrete foundations of a road which had presumably been designed with adequate strength to support the loads upon it and which was protected from wear by a surfacing material of wood blocks, asphalt, bitumen, or the like. Road engineers might well direct their attention to the condition of the old concrete in Wilton-road and its very considerable variation in condition. It was, no doubt, that variation which required that the concrete should be relaid. But what caused it to occur? Could the concrete foundation of a road be laid in such a fashion as not to need tearing up at such frequent intervals, noisy road drills, while no more bearable than formerly, would, at least, less frequently torture the public.

As to the silencing of the machines themselves and the difficulties that manufacturers have found owing to increased back pressure and freezing, a possible solution is suggested by the article in this issue descriptive of a special de-humidifier air compressor for South Africa. In that machine, by the expenditure of 10 per cent. more power than usual, de-humidified compressed air is delivered to the pneumatic tools in the mine. Although the cooling and drying of the air at the working faces and the consequent improvement of the conditions under which the miners work is the primary object for which this compressor has been designed, de-humidified air can naturally be expanded to a greater degree without fear of freezing. The makers claim, in fact, that 54 cubic feet of de-humidified air will perform as much useful work as 100 cubic feet of ordinary compressed air. We therefore commend the possibility to makers of portable compressors and pneumatic tools that the provision of de-humidifier apparatus might make possible, not only the fitting of more adequate silencers for the lower-pressure exhaust air without fear of freezing, but also an increase of efficiency. Meanwhile we congratulate the Westminster City Council on its far-sightedness in giving manufacturers the opportunity to demonstrate and compare their products. Within the next few months the Council is again to conduct a similar test, probably on a layer of concrete specially prepared for the purpose. We confidently hope that when that time comes the tests will demonstrate that a further advance has taken place.

Literature.

The Story of Telford. By Sir ALEXANDER GIBB. London: Alexander Maclehose and Co. 1935. Price 16s.

IT is a fact worthy of observation that in the realm of civil engineering many of the greatest works were originated and carried out by men with no training, and with none of the mathematical and technical knowledge of material which is now held to be essential. They employed little more than such common sense as could be acquired watching the work of craftsmen and by, in some instances, the practice of the mason art. We do not know that there is any evidence to prove that they used material extravagantly, and so much of their work remains that we may say they used it adequately. "R. L. S.," in the records of his family and particularly of Robert Stevenson, his grandfather, says: "But the province of formulas and constants is restricted. Even the mechanical engineer comes at last to an end of his figures, and must stand up, a practical man, face to face with the discrepancies of Nature and the hiatuses of theory. . . . With the civil engineer, more properly so called (if anything can be proper with this awkward coinage), the obligation starts with the beginning. He is always the practical man. The rains, the winds, and the waves, the complexity and fitfulness of Nature, are always before him. He has to deal with the unpredictable, with those forces (in Smeaton's phrase) that 'are subject to no calculation'; and still he must predict, still calculate them, at his peril." Amongst such men Telford holds the highest place in this country. Coming of a poor Scottish family he was apprenticed at an early age to a mason. Upon that small base he built up a career which made him for fifteen years of his life the most eminent engineer in the land.

Little or nothing is known about his boyhood and his work as a 'prentice. In 1780 he went to Edinburgh, where he practised masonry, and, so he claimed in after days, "studied every form of architecture." A couple of years or so later, when he was twenty-four years of age, he set out for London with a few letters of introduction in his pocket. There he was engaged as a mason on the building of Somerset House, designed by Sir William Chambers. We have some glimpses of him at this period, and they are not very pleasant. To be frank, he was then a prig. Thus, he writes to his friend Andrew Little: "At present I am laying schemes of a pretty extensive kind if they succeed, for you know my disposition is not to be satisfied unless when plac'd in some conspicuous point of view. My innate vanity is too apt to say when looking on the Common drudges—here as well as other places—Born to command ten thousand slaves like you." In 1784 he writes to Little from Portsmouth, where he was engaged on the building of the Commissioner's House: "The consolation is, that all my proceedings are approved by the Commissrs. and Officers here, indeed, so far that they would sooner go by my advice than my Masters." Again, he tells Little that "knowledge is my most ardent pursuit, a thousand things occur that would pass unnoticed by good easy people who are contented with trudging on the beaten Path, but I am not contented unless I can reason on every particular."

The Commissioners House was finished by the end of 1786, and Telford moved to Shropshire, where, possibly through the influence of Sir William Pulteney, he was appointed Surveyor of Public Works for the County of Salop. Little is once more his confidant, and again the prig is seen; to him he writes: "You know while I was in Eskdale I was a bone of contention, when I came to London I had nearly raised a confusion at Somerset House—at Portsmo' the navy Bd. and Admlty were engaged and since my arrival here, there has been one continual scene of contention, when I have been always the prominent feature." This is a not uncommon type of vanity, and the example, taken with others which we have quoted, shows that young Telford had indeed "a guid conceit of himsel'."

The self-conscious virtue of the prig is often enough no more than a coating of whitewash, but Telford took care to ensure that his belief in himself was justified by his actions. He worked like a black, both in his immediate duties and in the expansion of his mind and imagination. His first bridge, the Montford, which still stands, was built when he was no more than thirty-three years of age, and he followed it with the famous bridge at Buildwas, the second iron bridge in Great Britain. It was inspired by its predecessor at Coalbrookdale, which had always interested Telford, but in which he detected errors of design. It is a little bit strange, despite his belief then and probably to the end of his days, in the use of iron for bridge building, that out of the forty-two bridges he built in Shropshire only five were of iron. For the famous Chirk Aqueduct on the Shrewsbury Canal he rejected the complete iron trough which had been contemplated, and only the bottom was made of that material. But he employed iron subsequently in another place, Beeston, in Cheshire, for the construction of a couple of locks on quicksand. As his biographer observes, the predilection "was not without its effect on the favourable attitude of the ironmasters towards him."

By the end of the eighteenth century when he was only forty-three years of age, Telford's reputation had ceased to be local and become national. He devoted less and less time to Shropshire. He was engaged on works in Liverpool and busy with plans and schemes in the Metropolis. Of these, the rebuilding of London Bridge must, of course, be given the place of honour. For it he proposed an iron structure, and the recommendation of the London Port Parliamentary Committee in 1800 was that the bridge should be made of that material and according to plans which Telford asserted were submitted by Douglas and himself. It had five arches; but in the following year a bridge with but a single iron span of 600ft. was put forward. A plate of it was printed and a description, now exceedingly rare, written by Douglas and Telford, was published. But, as everyone knows, the great scheme fell through, the times were unpropitious, Telford got tired of waiting, and his partner "played a Pliskey" on him and disappeared. In Sassenach, "pliskey" is an underhand trick. It does not appear to have done Telford any serious harm.

Sir Alexander Gibb has sought out records of all Telford's work and finds something interesting to say about each but it would take too much space to follow in detail all the activities of a man who was never at rest. We must therefore pick one or two here and there. Chronologically, the survey of the Highlands and the construction of the Caledonian Canal come first in order. Whilst avoiding tedious details, Sir Alexander manages to show the difficulties and troubles, other than technical, which a civil engineer of a great national undertaking has to face. Telford seems to have been in and out of trouble with the Government pretty constantly, and it was fortunate for him that John Rickman, secretary for Highland Roads and Canals, was his stout ally throughout. "To their unbroken collaboration," says the biographer, "was due the successful completion of the Highland works." The Caledonian Canal is unquestionably a "popular" work, and it may be "curious," as Sir Alexander says, but not surprising that Telford's fame "should have been due to a work, which great as it was, had the least permanent effect of any of his larger works." But it is doubtful if his fame does really rest on that undertaking. We question if one in a hundred who have heard of Telford Roads know that he constructed the Caledonian Canal.

Telford was, in fact, the first civil engineer who condescended to look upon road-making as falling within his province, and he was the first to treat road-making scientifically. He had gained no little experience in such work before he was called in, in 1810, to deal with the Holyhead Road, then one of the main connecting links between England and Ireland, but broken by the unbridged gap at the Menai Straits. Years passed before any progress was made, for it was not till 1817 that Telford received definite instructions to prepare plans for a suspension bridge over the Straits, and the actual erection of the ironwork did not start till March, 1823, when he was getting an old man. It was not completed till three years later. Sir Alexander gives the history of the bridge succinctly, but interestingly, and deals also with the not less important part of the whole plan, the highway between London and Holyhead. In this connection he contrasts the diametrically opposed methods of Macadam, who cared not a whit for foundation "clay, sand morass, or bog," and Telford, who insisted on a sound bottom of large stones.

Telford carried out many more great works before his death in August, 1834, in his seventy-eighth year. A list of these works fills nearly thirty-two pages of the volume. But we shall deal only with one more of the edifices he helped to erect, one that is destined to outlive all the others—the Institution of Civil Engineers. As a matter of fact, the Institution was in being two years before he became its first President. Yet it may be said the foundations were well and truly laid by him. "He possessed," says our author, "an unusual combination of vision and enthusiasm, with a clear grasp of hard fact and dull detail; he was not only filled with an unquenchable desire to share his experience with others, but he had always particularly cared for the training of young engineers. . . . He was peculiarly fitted to be at once the father of a new institution and a new profession, and the instructor and inspiration of its members." Once appointed President, he threw himself with characteristic energy into the task of making the Institution an organ "for the advance of engineering, rather than of engineers." He was a very frequent attendant at its meetings, and often brought with him guests and students after his regular Tuesday dinners in his house in Abingdon-street. "He encouraged," we are told, "the presentation of papers on actual works, put forward by members or guests on their own practical experience. He rather scorned theoretical disquisitions and discussions, which he thought generally led nowhere." He established the Institution in a firm position, and in a few years every civil engineer in the kingdom sought admission to membership.

Here we must leave a book which we have enjoyed reading. It is a long-needed addition to the library of the lives of engineers, and may be commended to all who are still young enough to find inspiration and impulsion in the works of great men, and to the older who hold in memory the men who have raised British engineering to the position it occupies. Sir Alexander Gibb has done his work well and conscientiously and in the doing of it has paid a noble tribute to a great engineer with whom his own ancestors were professionally associated.

BOOKS RECEIVED.

Cast Iron Pipe: Its Life and Service. Nottingham: Stanton Ironworks Company, Ltd., Stanton. No price stated.

British Rainfall, 1934. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C.2. Price 15s. net.

Physics. By E. Hausmann, Sc.D., and E. P. Slack. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 20s. net.

Examples in Heat and Heat Engines. Second edition. By T. Peel, M.A. London: Cambridge University Press, Fetter-lane, E.C.4. Price 5s. net.

The Port of Basrah, Iraq. Compiled by C. Byford, A.M. Inst. T. London: Crown Agents for the Colonies, 4, Millbank, S.W.1. No price stated.

Metalliferous Mine Surveying. Second edition. By F. Winiberg. London: Mining Publications, Ltd., Salisbury House, E.C.2. Price 15s. net.

Electricity in the Home and on the Farm. By F. B. Wright, Ph.D. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 12s. 6d. net.

Power Plant Chemistry. Fourth edition. By A. H. Gill, Ph.D. London: McGraw Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 15s. net.

SIXTY YEARS AGO.

CAPTAIN EYRE M. SHAW, one-time head of the London Fire Brigade, deserves to be remembered to-day by more than the line in "Iolanthe" in which Gilbert immortalised his name. He took his professional work very seriously and withal was of a literary turn of mind. In 1876 Messrs. Spon published a book from his pen dealing with fires in theatres in which he showed that he had both the qualities which go to the making of a historian and the zeal of a constructive reformer. Theatres always have been peculiarly open to risks of fire partly no doubt because of the inflammable nature of the scenery and other properties employed—or formerly employed before certain regulations were imposed—and partly because the construction of a theatre with its large proscenium opening is well adapted to promote the spread of fire. According to Captain Shaw's record, admittedly an incomplete one, between the year 1772 when Drury-lane Theatre was burned down and 1876—that is in the space of 104 years—112 theatres were destroyed outright by fire. The Opera House, Paris, was burned down on five occasions, the two most recent at the time when Captain Shaw wrote being in 1871 and 1873. If the destruction of the Elstree film studios last week end hardly comes under the same heading the fire which destroyed the Royal Opera House at Turin last Saturday night, February 8th, certainly does and proves that the problems to which Captain Shaw addressed himself sixty years ago have not as yet been completely solved. His first concern was to ensure that the occurrence of a fire in a theatre should not cause loss of life in the audience. To secure that end he placed, in descending order of importance, the provision of perfect facilities for the escape of the audience from the building without crushing or trampling, the construction of the building in such a way as to reduce the risk of fire to the minimum and the provision of means of localising a fire, should one break out, at any event for a sufficient length of time to allow the audience to escape. Reviewing Captain Shaw's book in our issue of February 18th 1876 we said that nearly every theatre in Great Britain violated one or other of the rules of construction which he laid down. Not a few London theatres, for instance, had their means of entry and exit through other adjoining buildings and not directly from or to the street. There was, too, hardly a theatre in London which had a lobby running round the auditorium in which the whole audience could be accommodated in a lightly crowded condition. Captain Shaw's argument in favour of such a lobby was that it would provide a space with a wall intervening between it and the fire. We approved of his suggestion that all passages leading to the auditorium should be wider at the outer, or street, end than at the inner end in order to provide a crowd rushing through them with more and more room as it proceeded. We also agreed with him that, as a fire was more likely to occur on the stage or behind the scenes than in the auditorium, the house should be divided into two portions by a massive wall. Any side openings in this wall should be closed by means of iron doors. The proscenium opening in the wall should be capable of being closed at a moment's notice by means of a metal curtain. Such curtains had been tried but had not found favour with theatre managers. Nevertheless Captain Shaw believed, and we supported him in his belief, that engineers given a free hand would not hesitate to accept an order for such a curtain and would guarantee it to prevent the passage of fire for at least an hour. . . . The fireproof curtain of asbestos which we know to-day did not apparently come within Captain Shaw's range of vision.

Recent Practice in Hydro-Electric Power Development.*

By B. HELLSTROM, M. Inst. C.E.

No. I.

1. Hydrology and Duration Curves.

IT is, of course, impossible to deal adequately with recent practice in hydro-electric power development in the short space of four lectures, so I have to confine myself to what I might call selected chapters. They have been chosen mainly from the civil engineering side; the mechanical parts of a power scheme will be only briefly referred to, and electrical questions will be disregarded altogether.

In this lecture I shall deal with variations of water level, wind effect, discharge measurement, duration curves of flow and power, co-operation between water power and steam power, floods, flood probability and flood erosion.

A.—Variations of Water Level.

For estimating the flow of the water the primary statistical material consists of readings of water levels. For this purpose ordinary gauges are erected which should preferably be read daily. Automatic registering gauges are to be preferred where there is a daily variation in the flow—for example, below an existing power station where the flow may vary with the load. Even where an automatic gauge is installed, an ordinary gauge should be erected as well and read at intervals, so as to obtain a check on the automatic gauge, which might get out of order or show erroneous results. In this connection too much stress cannot be laid on the necessity of erecting distinctly marked, well-described, and easily discoverable bench marks near the gauges. There should be at least two bench marks at each gauge, by means of which the height of the gauge can at intervals be checked.

Broadly speaking, the variation of the water level in a river, or a lake, can be divided into secular, annual, daily, and occasional variations, of which the first three may be of a periodic character. Periodic variations over a limited number of years are also of importance.

Secular variations are generally not of great importance in connection with hydro-electric development. Where a study of these variations is made, it is generally necessary to call in geologists and experts for the study of alluvial deposits, &c.

Variations having a period of several years are often studied in connection with big lakes, a reason for this being that records of the variation of the water level are often available for long periods in such lakes. For the big lake Vänern in the south of Sweden, with an area of 2150 square miles and a catchment area of 18,800 square miles, it has been found that, in addition to the annual period there are also variations with a period of two to three years, eleven years and (though this is not certain) of forty years. These data are based upon observations of the water level since 1807. Fig. 1 shows these interesting records based on monthly averages. The annual period is easily distinguished, and it will be seen that, for instance, in the years 1816–1818 the water level was high, whilst in 1855–1859 it was very low.

For the water power scheme the annual variations are very important. If records are available for a period of, say, ten or twenty years, it should be realised that in particular the maximum and the minimum water level and the corresponding maximum and minimum discharge experienced in subsequent years may deviate considerably from the extreme levels on record. This refers to low water as well as to floods, and will be dealt with later on.

The water level may be subject to great daily variation if the water is utilised in a hydro-electric power station, but other factors also are of importance. If the catchment area is small, the daily variations may be large during periods of flood. For snowbound catchment areas the heat of the sun may create a maximum in the daytime, and the cold nights a minimum at night.

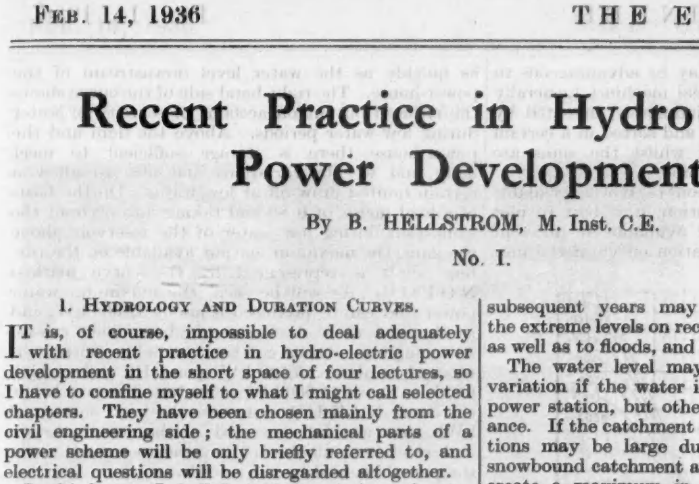

FIG. 1—*Water Level Variation in Lake Vänern, 1807-1934. Monthly Averages.*

B.—Wind Effect.

Occasional variations may occur, for instance, on account of the effect of the wind on the water level. This applies to rivers as well as to lakes.

The computation of the effect of the wind on the height of the water level in lakes, reservoirs and rivers is an interesting and complicated hydrographic problem. This question is, for instance, of importance in determining the highest water level that may occur above a dam. Speaking generally, the gradient of the water surface is inversely proportional to the depth, and the rise (or fall) of the water surface depends upon the length and topography of the lake, and can be taken approximately as proportional to the square of the velocity of the wind. In lakes, the wind force causes currents to flow in the same direction as the wind in the upper layers of the water, and equilibrium is restored by currents in the lower layers flowing in the opposite direction. To overcome the resistance to the currents in the lower layers, a denivellation of the water surface takes place by which the surface of the lake is lowered at the windward and raised at the leeward shore. In rivers the wind force will increase or decrease the velocity of the water according to whether it blows with or against the flow. The water surface is thereby lowered or raised, as the case may be.

There are a great number of records showing a rise (or fall) of many feet when an ordinary strong wind is blowing. On January 27th, 1923, owing to a storm, the water level at the outlet of lake Vänern fell 2·0ft., and the discharge was temporarily reduced from 10,500 to 6900 cusecs. This seriously affected the output at Trollhättan power station and other power stations below the lake.

Lake Hornborga in Sweden is a shallow lake with a normal depth of 3ft. to 4ft. only, and an area of 6·9 square miles. When a fairly strong wind blows upstream from the outlet, it may happen that the latter runs dry and no water is then available for the power stations below the lake. On the other hand, when in the dry summer months a strong wind is blowing towards the outlet, the river has to discharge flood water.

Fig. 2 shows the water level in the Baltic on November 13th, 1872, at noon, when a wind of 75ft. to 85ft. per second was blowing. As will be seen, the water level rose 6ft. to 8ft. above the mean level between the south of Sweden and Germany. At the same time the water surface was lowered 3ft. in the Gulf of Finland.

C.—Discharge Measurement.

To ascertain the relationship between the water level and the discharge, it is necessary to measure the flow at different water levels. If a diagram is plotted of the water level and the discharge, a discharge rating curve is obtained.

A rough estimate of the discharge can be made by observing the velocity of the water by means of floats. These may either float on the surface or have parts submerged in the water, so as to obtain the average velocity in a vertical section. Although this method is very approximate only, it may be of interest to refer to an investigation, carried out in Germany some years ago, to compare the average velocity of the water in the whole section (v_m) with the maximum surface velocity (v_{max}). The material for this investigation consisted of 3700 measurements. After having selected 1200 measurements applicable to straight rivers with cross sections without any pronounced irregularities, the relationship found between v_m and v_{max} is given in Table I.

For these measurements the average velocity of the water over the whole cross section varied between 0·3ft. and 7ft. per second. Naturally the method of measuring the velocity of the water by floats is of small practical value, and should be used only when no accurate methods can be applied. It may, however, be used when big floods occur and no other method is available.

TABLE I.—*The Relationship* $\frac{v_m}{v_{max}}$ *Between the Average Velocity and the Maximum Surface Velocity.*

Width of cross section.	Section obstructed by reeds and grass.	Material of river bed. Boulders.	Gravel and coarse sand.	Sand and clay.	Section lined with wood, concrete or stone.
Less than 10ft. ..	0·53	0·62	0·68	0·73	0·80
10ft. to 33ft. ..	0·57	0·63	0·69	0·75	0·81
33ft. to 82ft. ..	—	0·65	0·71	—	—
82ft. to 165ft. ..	—	0·68	0·73	—	—
More than 165ft.	—	—	0·74	—	—

Accurate measurements of the flow are generally made by a current meter. This consists of a small screw or a bucket wheel calibrated in the laboratory to fix the relationship between the velocity of the water and the number of revolutions of the screw. The velocity in a cross section of the river should be measured in suitably selected verticals at several points in each vertical, so that a velocity diagram for each vertical can be drawn. One point for measuring the velocity should be taken close to the bottom, another close to the surface; the other points being separated by a vertical distance of one or several feet, depending upon the depth. Soundings are taken of the depth of water, not only at the verticals where the measurements are made, but also between these verticals so as to obtain a correct cross section of the river. The computation of the flow is then suitably carried out graphically. The mean velocity of the water in each vertical is plotted in one diagram, the other diagram showing the product of the mean velocity and the depth. If this area is measured, it gives the amount of flow. In points where only the depth has been ascertained, this should be multiplied by the average velocity at that point, taken from the first-mentioned diagram. In this way, greater accuracy is obtained than if only the velocity in the verticals, where the velocity has been measured, is taken into account.

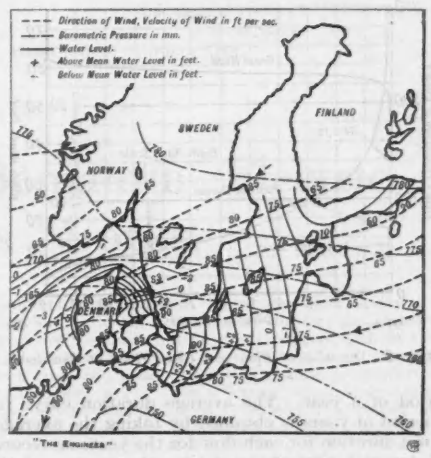

FIG. 2—*Water Levels in the Baltic on November 13th, 1872.*

Sometimes discharge measurements are carried out by observing the velocity at one point only of each vertical. This point is generally chosen at a distance below water level of 0·6 of the total depth, the computation being made on the assumption that the velocity at this point gives the average velocity for the vertical in question. This method is by no means certain to give an accurate result. I have personally made a special investigation of this matter, and I found that in a large river (the Perak River in the Federated Malay States), at different water levels, the discharge estimated by the first-mentioned, more accurate method was about 8 per cent. less than the discharge estimated by the latter method of measuring the velocity at one point only at each vertical. I have made particular mention of this, as I understand that in some countries the less accurate method is frequently used.

When the flow of water has been ascertained at different water levels, the discharge rating curve is drawn. It is generally futile to attempt to express this relationship between discharge and water level by a formula, and a graphic method is to be preferred. For the computation of the discharge rating curve, it is advantageous to ascertain the point where no water flows through the cross section. This point is found by levelling the river bed in and below the cross section where the measurements are made.

It should be borne in mind that the discharge rating curve may undergo certain changes due to erosion, silt deposits, &c. In summer when bottom vegetation may be abundant, the discharge rating curve

* Lectures delivered at the University of London on November 6th, 8th, 11th, and 14th, 1935.

may have a somewhat different character than in winter. In countries where the temperature falls below freezing point, the existence of ice in the water, or on the surface of the water, may have a considerable influence on the discharge rating curve.

If it is at all possible, measurements of the flow should be made when there are no appreciable variations of the water level during the period of measurement. When the river is rapidly rising or falling, the flow at a certain water level may be somewhat different from the flow at the same water level under steady conditions. This particularly refers to the time when the river is in flood. It should also be noted that the effect of the wind on the height of the water level may be considerable. If the wind is blowing along the river and against the current, the water level is raised, and *vice versâ*. Measurements should therefore preferably be taken when no wind is blowing. It is important that the gauge be read immediately before as well as after the measurements.

For obvious reasons, it is not necessary to measure the flow of the river at the place where the gauge is situated, as long as no appreciable inflow to the river takes place between the gauge and the cross section where the measurements are made.

D.—Duration Curves of Flow and Power.

When the discharge rating curve has been computed, hydrographs are prepared showing the flow of water day by day. When considering the flow which can be utilised in the water power station, it is most practical to study these by means of duration curves. A duration curve of the flow is a curve of which the abscissa at any point shows the percentage of time during which the flow was equal to or exceeded the amount shown by the ordinate of the curve at that point. The curve is generally obtained from the hydrographs and shows the number of days (duration) that the flow equalled or exceeded a given amount. The area below the curve represents the total run-off of the river at the section to which the records apply. Duration curves can, of course, be made for any interval of time, but are generally prepared over a

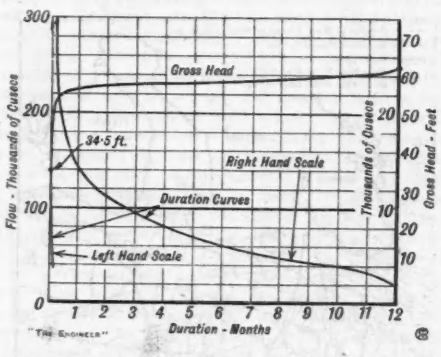

FIG. 3—*Duration of Flow and Gross Head at Chenderoh.*

period of a year. The average duration curve for a period of years is obtained by taking the averages of the duration for each flow for the years on record. (If, for each percentage of time the average of the discharge of each year is taken, another curve is obtained, which does not satisfy the definition given of the duration curve and which is of little or no use in this connection.) The average duration curve for a number of years will thus show both the actual maximum and minimum discharge observed during the whole period as well as the average flow of the whole period, represented by the area below the curve. As an instance, 95 per cent. time-flow, designated by Q 95, is the flow occurring at the site 95 per cent. of the time when the total period of the record is considered. Similarly, the 50 per cent. time-flow, designated by Q 50, is the flow occurring 50 per cent. of the time when the total period of the record is considered.

The World Power Conference has adopted as a basis for its international power statistics the rates of flow, taken from the average duration curve as defined above, corresponding to Q 95, Q 50, and the mean flow, using the gross head and 100 per cent. efficiency and expressing the theoretical capacity in kilowatts.

When tables of daily (or weekly) discharge are available, the duration curve may be computed by tabulation, *i.e.*, by ascertaining the time during which the discharge has been higher (or lower) than certain values, and tabulating the results. The tabulation should be arranged so that a check on the computation is obtained.

Another method of computing the duration curve, by which the work of tabulation is avoided, is based on the use of the hydrographs. By employing an ordinary divider the time is graphically measured during which the flow has exceeded (or fallen below) a certain value. The time thus measured is then directly transferred to the diagram of the duration curve. The operation is repeated for another value of the flow, and so on, until sufficient points have been obtained to draw a continuous curve. The time unit used for the latter will then be the same as that used in the hydrograph.

When the duration curves for a great number of rivers have to be made, it may be advantageous to make the calculation by special machines (generally used for statistical work in industries) invented by Hollerith. Cards are marked and sorted in a certain way by a sorting machine, whilst the sums are obtained by a tabulating machine.

For calculating the duration of power available at a certain water power station, it is best to plot the gross and the net head available at different flows. Fig. 3 shows the duration curve of the flow

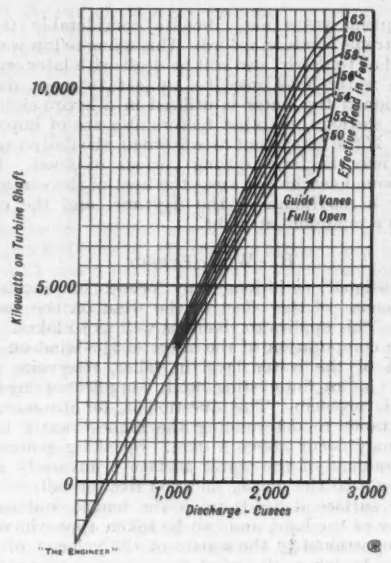

FIG. 4—*Output on Turbine Shaft Related to Discharge and Effective Head.*

and the corresponding gross head for the Perak River in the Federated Malay States at Chenderoh, where a hydro-electric station was built a few years ago. This scheme comprises a hydro-electric station at Chenderoh with three units with a normal rating of 9000 kW each at a head of 60ft. This station is linked up with a steam power station at Malim Nawar with three steam turbine units each of 6000 kW, some 45 miles from Chenderoh, by a 66 kV, double-circuit transmission line.

To obtain the power available, the net head at the turbines is calculated and a diagram is prepared giving the output of the turbines at varying discharge and corresponding net head. Such a diagram, also from the Perak hydro-electric power development, is shown in Fig. 4. The output on the turbine shaft in kW depends on the discharge through the turbines and the effective head. When the guide vanes are fully open the turbine can produce 8800 kW at a head of 50ft., and 11,800 kW at a head of 62ft.

On the bssis of this diagram and the duration curves

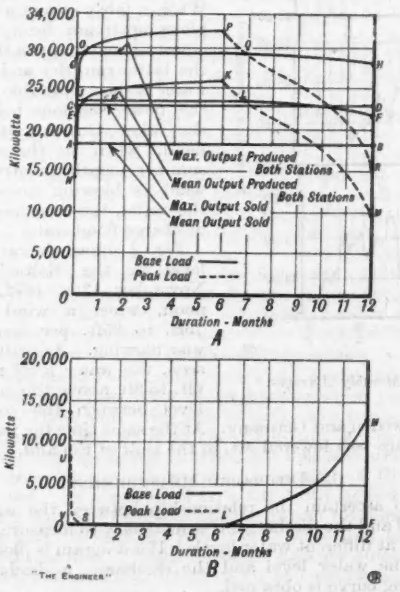

FIG. 5—*A, Power Available at Chenderoh and Output at Consumer Terminus; B, Power Required from the Steam Station.*

shown in Fig. 3, the duration curve for the power output can now be computed, and Fig. 5A shows the duration curves of power for the Perak scheme.

The mean output available on the turbine shaft at the hydro-electric station is shown by the curve N J K L M. N corresponds to the output at very high flood, and M to the mean power available at the minimum discharge of the river. During periods when water is abundant, represented by the left part of the curve, the output is reduced on account of loss of head. This is due to the fact that during floods the water level above the dam does not rise as quickly as the water level downstream of the power-house. The right-hand side of the curve shows the reduced output on account of scarcity of water during low-water periods. Above the dam and the power-house there is storage sufficient to meet daily and weekly variations and also to allow a certain limited draw-off at low water. On the basis of a load factor of 0·80 and taking into account the utilisation during low water of the reservoir above the dam, the maximum output available on the turbine shaft is represented by the curve marked N O P Q R. As will be seen, the maximum water power that can be produced is about 32,000 kW, and is obtained at a discharge of about 6000 cusecs. At minimum discharge the available output is reduced to about 15,500 kW (point R), and at high floods to about 14,000 kW (point N). The area below the curve N J K L M represents the total number of kWh that can be generated in the power station and which is available on an average per annum over the period covered by the records.

(To be continued.)

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

INCENTIVES AND THE PRACTICAL MAN.

SIR,—When are we to see the end of the bitter intolerance and blind scorn of the "practical man" when confronted with the work of the scientist, especially the specialist or pioneer scientist? Your second Leader this week begins by claiming that, in psychology, and in the particular branch of it relating to incentives, no engineer has anything to learn, or has learnt anything since the time of the ancient Greeks. The second part of this claim may be true of individuals, but the first is a sheer bluff, as any intelligent apprentice or tradesman in even the best-run engineering works will tell you. (Why, for example, do so many good lads dislike their work and mistrust their very well-meaning employers?)

After such an opening, it is not surprising to find that psychology is first condemned on the grounds that it is not a science (and it is admittedly only a very immature one), and is then rated because it attempts to employ the truly scientific method of reducing the number of possible variables to a minimum. It is the lack of this method that renders a great deal of engineering research, especially "practical" research, so wasteful and futile. Many results are obtained almost by accident, and a surprising number of these cannot be reproduced, *i.e.*, are lost for lack of scientific method.

This letter is not an attempt to belittle the absolutely essential virtue of common sense, or to deny that the practical man may have this virtue and the scientific enthusiast may often forget it. But what is common sense if it is not a sense of proportion in assessing evidence? and it is gross lack of proportion deliberately to ignore and discourage the evidence submitted by "pure" and would-be pure scientists. What we all need is enough humility to realise that we do not know everything, and that no man is entirely a fool. Whether he is an old fool or a young fool, the odds are that he knows something new to us, and is anxious to pass it on. Need I add that I am a young one?

GEORGE JAGER.

Bury, Lancs., February 3rd.

WATT AND THE GLASGOW HAMMERMEN.

SIR,—During the memorable week of celebration of the bicentenary of the illustrious James Watt—Greenock's most distinguished son—it would have been unpardonable to have introduced any controversial note. It is unfortunate, however, after having been, it was thought, finally disposed of in 1911, that the unfounded charge against the Hammermen of Glasgow, who are accused of refusing permission to Watt to work at his trade in that city, should have been given a new lease of life. In the pageant of Watt's life, produced at Greenock during the bicentenary week, Episode IV is reported as follows:—"Eager to get ahead with his life's work, he is hampered by the opposition of the Glasgow Guild of Hammermen, who refuse to allow him to go into business." It may, no doubt, be reasonably said that the scene in question, so ably and sympathetically written, produced, and presented, must be regarded as merely a picturesque incident permitted by artistic license, and the gifted author of the pageant may be well forgiven for falling into error, when such writers as Arago, Williamson, Smiles, the late Duke of Argyll, and Dr. Jacks have, in turn, repeated and embellished this unfounded story (which latterly included the Corporation of Glasgow and the Trades House in its orbit). But when such a distinguished scientist as Lord Rutherford in the course of the Watt Anniversary Lecture delivered by him to the Greenock Philosophical Society, and fully reported in your issue of 24th ult., falls into the same error, however fairly he may have qualified his reference, it is only right in the interests of historical accuracy and of common fairness to the "premier" Craft of the Trades House of Glasgow—that great focus of the city's benevolence—that it should be corrected. In 1911, in an exhaustive review, Dr. Harry Lumsden, who "traced the legend through twenty different works," and who, as an authority upon craft history, is unexcelled, proved

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conclusively that the story was without foundation, and that "so far as the hammermen are concerned, there is absolutely no record against them." His concluding paragraphs are as follows :—

"It is sincerely to be hoped that no more charges in relation to James Watt will be made against the incorporation of hammermen, the Corporation of Glasgow, or the Trades House, and that those already made will now be discountenanced. The story that they persecuted and prohibited or prevented James Watt from starting business in Glasgow is nothing more than a baseless myth.

"It is perhaps too much to hope that future historians and biographers will pay more attention to modern historical methods and recognise the great need in such work for personal investigation and research."

A leading article in the *Glasgow Herald* of December 26th, 1911, on the subject of this tale commences : "Most people learned in their youth, from the fable of the three black crows, how a simple fact becomes exaggerated by constant repetition," and after condensing and commenting upon Dr. Lumsden's article, concludes thus : ". . . the picturesque legend of the persecuting hammermen is clearly baseless. It deserves to be remembered only as an example of how myths are made."

Dr. Lumsden's review and the *Glasgow Herald's* leader will be found reprinted in the "History of the Hammermen of Glasgow," by Harry Lumsden, LL.B., Clerk of the Trades House of Glasgow, and Rev. P. Henderson Aitken, D.Litt., Oxford (Paisley : Alexander Gardner, 1912), at page 394 *et seq.*

ARTHUR MUIR,
Clerk to the Incorporation of Hammermen.

Glasgow, C.2., February 4th.

[Mr. Dickinson in his recent book on James Watt deals with this story, and shows how it arose through a statement made by Black.—ED., THE E.]

MECHANICAL STOKING FOR SCOTCH MARINE BOILERS.

SIR,—We note in your article on the above on page 157 of your journal of February 7th, that you state : "There are, of course, several vessels in service with mechanical stokers fitted under water-tube boilers." May we point out that there are at the moment fifty-seven vessels at sea fitted with water-tube boilers and mechanical stokers, and of these, fifty-one are fitted with Babcock boilers ?

W. GREGSON,
(Babcock and Wilcox, Ltd.).

London, E.C.4, February 11th.

COMPETITION OF COSTING.

SIR,—"Cut-throat" competition is still a complaint in many industries, in spite of the great improvements in trade. The most popular remedy in this country appears to be the formation of price rings, the object of which is to maintain prices. This appears to be accepted by many as the solution to all their troubles, in spite of the fact that it is economically unsound. In practice, there are often great difficulties in the way of operating these rings. In fact, few are absolutely "water-tight," and most of them can be got round by one means or another. Individually, benefits may for a time be derived, but nationally they must in the end have disastrous effects. Competition cannot be eliminated ; in fact, it is unhealthy to do so, but steps could be taken to see that all competition is put on a sound basis.

I would suggest that if a universal system of costing, suited, of course, to each particular industry, could be adopted by that industry, it would go a very long way in this direction. "Cut-throat" competition usually arises when the instigators have no proper costing system.

In my experience, the chief offenders in cutting prices below the cost of production do so because they do not know what their cost of production really is. A certain amount of this can, of course, be done without the firm concerned feeling it, especially if they happen to have some very profitable line which covers these losses. How much better it would be if everyone knew exactly which of their products were on a profitable and sound basis, and which were losing money.

If such a system could be made compulsory, and every firm in every industry in this country knew exactly how they stood at regular short intervals, and, further, where they were making profits and losses, a good deal of the unhealthy "cut-throat" competition would be eliminated, and all industries put on a sounder basis. I would go further than this, and make it compulsory for all firms to send in a return each four weeks to some central body showing their profits and losses. In cases of consistent losses investigation should be made and legislative action taken before the firm reaches a long overdue bankruptcy, in which process it is able to damage many of its creditors, besides depressing prices to an uneconomic level.

DAVID BROWN,
Managing Director, David Brown and Sons (Hudd.), Ltd.

Huddersfield, February 11th.

A Visit to the Benjamin Electric Company's Works.

ADEQUATE and otherwise satisfactory illumination is now regarded as an essential feature of all works. It increases production, decreases errors, and helps to eliminate accidents. Time and again, increased cheerfulness has been noted on the part of workpeople when a new lighting system has replaced an old and inefficient one. Both the modern sources of light and the fittings with which they must be used to secure the best effect are the outcome of careful investigation which has led to the establishment of an industry devoted to the production of lighting equipments designed on scientific principles. The care taken in the manufacture of such apparently simple things as electric lamp reflectors is, generally speaking, none too well understood. Nothing short of a visit to an up-to-date reflector factory can serve to familiarise the uninitiated with the exacting nature of the business and the scientific lines on which such a factory is run.

With an output of industrial electric light fittings claimed to be larger than that of any other factory of the kind in the British Empire or in Europe, the Brantwood Works of the Benjamin Electric Company, Ltd., in Tariff-road, Tottenham, N.17, is exceptionally well equipped, both from the point of view of routine production and development work. The company began operations in Rosebery-avenue, E.C.1, in 1908, and it moved to more extensive premises at Tottenham in 1918. Expansion of the business necessitated extensions in 1925 and 1927. Since our first visit to the factory in 1928 the floor space devoted to production and the number of workpeople employed have been nearly quadrupled. The factory, as we first saw it, now forms but one section of the assembly and hand work departments. The original buildings, with the extensions, are now used solely for work additional to the main production carried out in the new No. 2 factory on the opposite side of Tariff-road. In this large building, which we inspected last week, all the chief mechanical manufacturing operations from the design

TOOL MAKING DEPARTMENT

and production of machine and press tools to the final inspection of the finished product are carried out. Other products, apart from reflectors, are wireless loud-speakers, electric water heaters, and certain fittings for motor cars.

In the new factory are the tool shop and stores, machine shop, the small and large press shops, spinning department, annealing shop, raw material stores, and the vitreous enamelling department. The latter is a department of great importance and is run with considerable care, for satisfactory vitreous enamelling has a great deal to do with the performance of reflectors. If properly applied, the enamel gives a definitely diffusing reflecting surface, and the percentage of light reflected compared with that received on the surface has been known to be as high as 83 per cent., although 75 per cent. is more like the usual efficiency. The contour of reflectors is also of great importance; the shape must prevent as far as possible an internal baffling of light, which diminishes the emitting efficiency.

All tools used in the production of reflectors, &c, are made by the firm's own tool makers in the tool shop associated with the tool store, which contains, in addition to the innumerable tools required for the production of different kinds of reflectors, those needed for stampings, pressings, &c., for loud-speakers, water heaters, and motor car fittings. While much of the work is done on the presses in the new factory, certain products, such as shop window and cornice reflectors, &c., naturally demand a certain amount of hand work which is carried out in the sheet metal shop of factory No. 1.

But the new factory is the main centre of engineering interest. A machine shop is equipped for the production of the components for lighting fittings and those of other products. Batteries of heavy, medium, and light presses turn out the Benjamin one-piece reflectors and other stampings. When the company produced the one-piece reflector, it made an important advance, for the seam between the reflector proper and its neck was eliminated, and the vitreous enamelling process facilitated. Much experimental work is said to have been necessary to make the design a success, which would not have been possible without the co-operation of British steel manufacturers in producing steel capable of standing the stresses and strains involved in shaping from one blank a 20in. reflector, 17in. deep, a process sometimes involving seventeen separate press operations. Another Benjamin innovation is the "Saaflux" system, which not only enables the reflector to be detached complete with the lamp for cleaning, and simplifies wiring, but promotes safety by keeping the temperature of cables below the maximum value specified in the I.E.E. wiring regulations.

The spinning section of the factory has long been one of the most attractive departments, and visitors have always been keenly interested in the work, but in these days the department appears to be mainly devoted to the production of aircraft spinnings. Many annealing and pickling processes are necessary to preserve the ductility of the metal and to prevent scale which would seriously affect the coatings of vitreous enamel. Between stamping operations the shapes are therefore put through annealing ovens. Two large oil-fired boilers are installed in the boiler house for heating the factory and for heating pickling vats, &c. Two other boilers for similar purposes are to be found in other parts of the works. The ware is conveyed to the pickling and cleaning vats in Monel metal baskets, which are lowered into and raised out of the vats by an electric hoist. On leaving the rinse tanks, the ware is placed in hot air heaters, in which it is thoroughly dried before passing to the enamelling shop.

To ensure that all metallic particles are removed from the enamel, it is passed through a magnetic separator, whilst an overhead conveyor enables the enamel issued to the shop to be withdrawn from time to time and resieved, to ensure complete absence of foreign matter.

After passing through the dryers, heated by waste heat, reflectors with a ground coating applied after inspection, pass to one of the muffles. The first firing operation then takes place and another inspection is made. They are then passed to other spray booths or dipping tanks for the application of the first coat of enamel, when they are again fired and after another inspection are given a final coat and fired in the first of the two muffles, which are oil fired, the second being automatically controlled and fitted with electrically operated doors. A small section of the factory is devoted to the work of applying transfers, stencils, and to special beading.

Finally, the finished articles reach the inspection section, which is under special control If they are satisfactory, they are wrapped and dispatched to the finished goods store, whilst blemished articles are scrapped, or, in minor cases, repaired. No pains are spared to maintain the high standard of the "Crysteel" enamel surface. The tests, daily or hourly carried out to this end, are too numerous to mention. Let it suffice to say that pickling solutions are tested twice or three times a day. The enamel is checked every two or three hours, whilst experiments are continually being made in an endeavour to still further improve the product.

Design, development, testing, and research are dealt with by the engineering department; whilst the lighting engineering service department deals with the application of the products to lighting installations. The designers calculate optical contours and lay-out the mechanical construction in accordance with the requirements of lighting service engineers. When models have been made to conform with these designs, the laboratory staff carries out tests and makes any modifications found to be desirable.

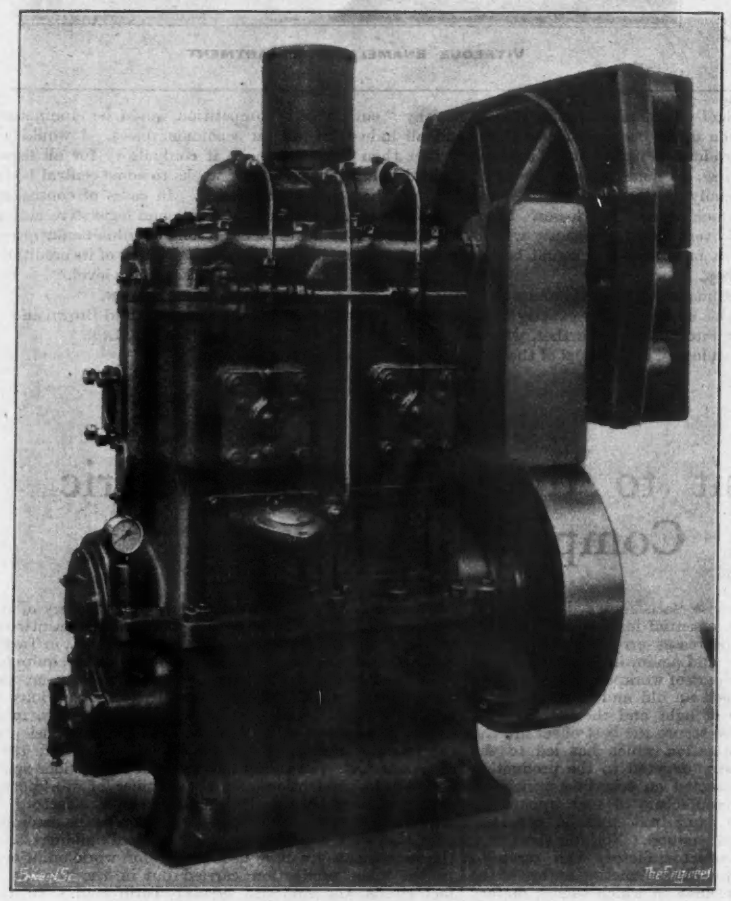
To ensure that the efficiency of equipment is maintained at a high standard during production, samples of vitreous enamelled reflectors and glass globes are taken from each batch and tested in the integrating photometer. The laboratory carries out researches on the optical properties of materials, particularly those that are newly introduced. It also investigates such matters as the dissipation of heat from lamps and the prevention of corrosion. The flat roof of the laboratory accommodates the outdoor test bed on which the performance of fittings is determined under practical conditions.

Activities of the company's lighting engineering service department are directed in the main to seeing that users of Benjamin products secure the best results. This involves a close study of the application under all conditions. Apart from adequate illumination, such items as the avoidance of glare, uniformity of illumination, diffusion, contrast, &c., are taken into account. Surveys are carried out in various industries and it is often possible when the plant involved is standard to prepare prescriptions and data books. There are, however, many installations which require an individual specification, and the engineering service department is continually preparing such specifications for all kinds of installations. To enable the effects of a proposed lighting scheme to be tested, the company is prepared to loan sufficient equipment for a trial, but where this is impracticable, photographs are supplied to show the lighting effect that may be expected.

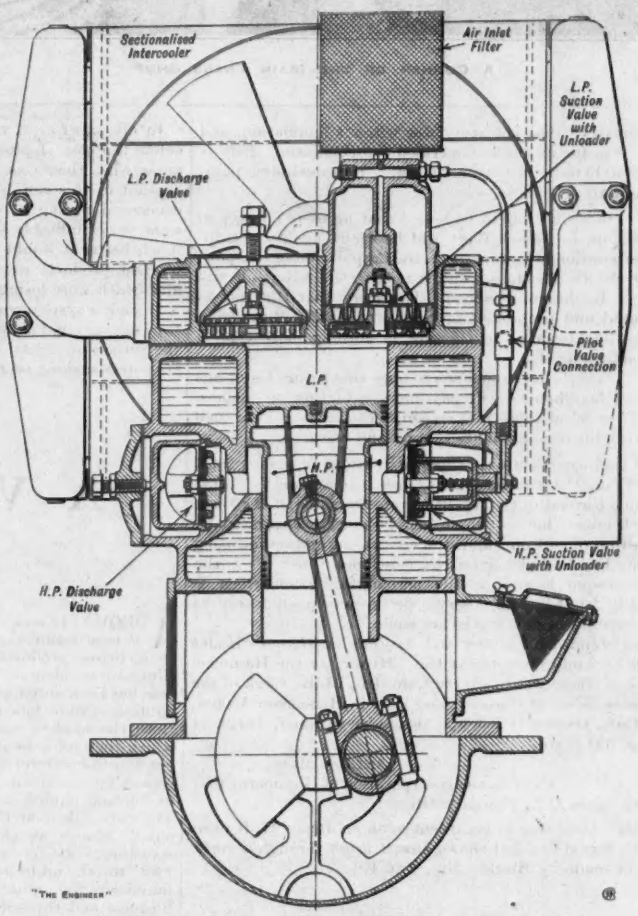
A Two-Stage Air Compressor.

THE compressor illustrated by the accompanying engravings is designed particularly for use in mines and other undertakings where skilled supervision is not obtainable. It is also intended to meet the conditions of high temperature and high altitude, which are likely to be encountered overseas. A cross section is shown in the drawing. Air is drawn through a filter into the cylinder above the piston during the downward stroke. On the upward stroke the first stage of compression takes place, and air is delivered to the intercooler. At the same time, air from the intercooler is drawn into the annular high-pressure space surrounding the lower part of the piston where, on the downward stroke, it is compressed to its final pressure and delivered to the air receiver. As the compressor is double acting and has a carefully balanced crank, even torque and smooth running are obtained. The intermediate pressure of 25 lb. per square inch acts on the larger piston area, whilst the final pressure is exerted on the small annular area of the lower part of the piston. In consequence, bearing loads are light. Cylinders and cylinder heads are water jacketed. It will be seen that the cooling area of the high-pressure space is per unit of volume much greater than in a normal cylinder. The intercooler is air cooled. It is secured to the compressor by the large pipes which convey air from the low-pressure to the high-pressure cylinders. It is built up of renewable elements, and is cooled by a fan driven by "Vee" belt from the crankshaft. Water cooling, owing to the small radiating surface of cylinders, is the most satisfactory means of keeping their temperature low, whilst air cooling has proved the more efficient for intercooling, because a large surface can be exposed to the air stream, and advantage is taken of the lower atmospheric temperature. All valves are of the multi-port plate type, and are retained by lantern rings. Unloading is effected by a pilot valve which, when a predetermined pressure has been reached in the receiver, admits air to operate small pistons, causing fingers to hold open the low-pressure and high-pressure suction valves. Oil is supplied under pressure to all bearings by a gear pump. Compressors of this type are made in sizes with capacities from 130 to 360 cubic feet per minute, and a volumetric efficiency of 84 per cent. is claimed when compressing to 100 lb. per square inch. A portable set, owing to its self-contained cooling system, is not ideal for obtaining maximum cooling, yet with a displacement of 250 cubic feet per minute at 1000 r.p.m. and compressing to 100 lb. per square inch, air temperatures as low as 225 deg. Fah. have, it is said, been obtained at a distance of 2in. from the compressor outlet.

The maximum continuous working pressure and speed for which these compressors are designed are 125 lb. per square inch and 1000 r.p.m. respectively.



TWO-STAGE AIR COMPRESSOR

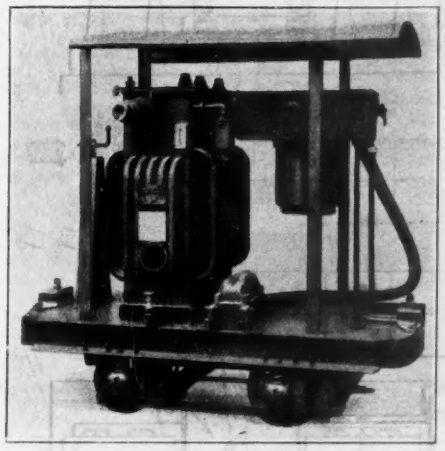


SECTION THROUGH COMPRESSOR CYLINDER

A Small Portable Sub-station.

THE portable static transformer sub-station shown in the accompanying illustration was built by the British Thomson-Houston Company to the order of New Consolidated Goldfields, Ltd., for use in South Africa. The advantages of such an equipment in quarries or mines in which there are light railway tracks are pretty obvious.

Power can be transmitted at comparatively high voltage, and a low-pressure supply may be given wherever required, thus avoiding costly low-tension distribution over a wide area. The unit shown consists of a 60-kW, three-phase, 50-cycle, oil-immersed, self-cooled, outdoor transformer, with a ratio of 3300/440 volts, and provided with plus and minus 2½ and 5 per cent. tappings on the H.T. side, with externally operated switches. A circuit breaker on the transformer tank is rated at 100 ampères, and has a rupturing capacity of 50,000 kVA. It has three overload trips and a tank-lowering device, which enables the tank to be lowered without dismantling the equipment. Cable entry on the H.T. side is through a compound filled sealing chamber in the circuit breaker body, and is provided with special armour clamps and earthing arrangements to accommodate a heavily armoured flexible cable, connected to a link box on the truck platform. The H.T. supply is brought to the truck from the tapping point by



PORTABLE SUB-STATION

a length of similar cable, terminating in a similar box on the truck platform alongside the first-mentioned box. Connection between the two boxes, which are enclosed by a common cover, is made by links. The low-tension terminals are connected to waterproof mining type four-pin plug and socket, which enables the L.T. supply to be rapidly disconnected. The plug has a sealing chamber for the L.T. cable.

The four-wheeled bogie on which all the equipment is mounted has a steel plate deck. A screw-down brake operates on all wheels, and a coupler is provided for haulage. Protection against tropical sun and rain and falling stones in workings is provided by a steel canopy. As the electrical equipment is totally enclosed, contact with live metal is impossible. Each piece of apparatus is solidly connected to the truck frame by heavy copper strip and a plate and length of bare stranded copper are provided to enable the unit to be properly earthed.

A New Impact Breaker and Granulator.

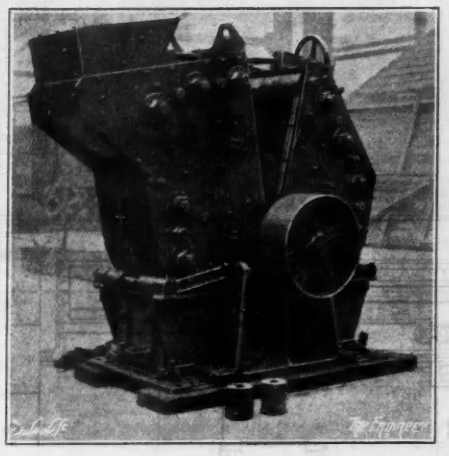
THE photograph and sectional drawings which we reproduce herewith represent a development of the impact type of rock breaker and granulator which has recently been brought out by H. R. Marsden, Ltd., of Soho Engineering Works, Meadow-road, Leeds, 11, with the object of overcoming some of the troublesome characteristics of this class of machine which have reduced its popularity.

One of the most common complaints raised against the impact breaker is the amount of time lost in the renewal of the parts which inevitably wear out, such as the hammers and liners. At the same time, it often happens that one-half to two-thirds of the weight of the expensive metal, of which these parts are made, must be prematurely scrapped. Evidence of this fact is to be found in the large dumps of scrap metal found in quarries and gravel pits where impact breakers are used. The tendency in this type of machine, particularly if the rate of feed is irregular and below capacity, is for the wear to be unevenly distributed over the lateral operating surfaces of the hammers and liners, with the result that after a short period of service they may be worn in the middle to such an extent that their effective usefulness as a reducing medium is at an end, whilst their extremities may still be sound and of their original dimensions and weight.

Fitting renewals has hitherto always been a tedious and prolonged process, and from the point of view of loss of output, owing to the inevitable frequent stoppages, very expensive. Two, three, or four men are generally employed in the work. Partial dismantling of the machine is often necessary in order to gain access to the internal parts, entailing the removal of numerous rusty bolts and nuts. Fairly substantial lifting tackle of a semi-permanent nature has to be provided owing to the heavy weight of the individual parts requiring removal or renewal.

In the new Marsden breaker, however, most of these difficulties have been overcome, and it is claimed that reduction costs have been reduced by at least 50 per cent.

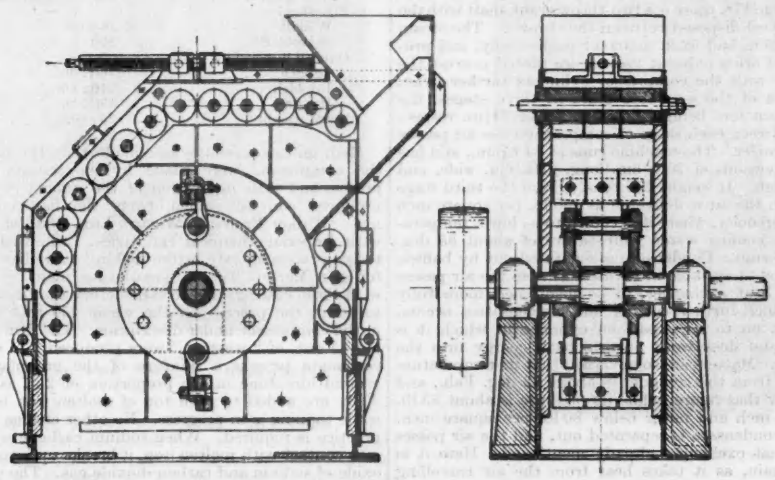
The body or casing of the granulator comprises three separate sections, viz., the lower, which is made of cast iron of substantial proportions, carrying the rotor, shaft, and its bearings; the upper two sections are made of mild steel plate, the division line coinciding with the shaft's vertical axis. The peripheral anvil wall connecting these two side plates is composed of a series of sectional



IMPACT BREAKER AND GRANULATOR

cylinders made of special metal with high abrasive-resisting properties, and structural strength, closely disposed to one another and supported in circular apertures in the side plates by spigoted discs, as well as on a polygonal steel mandrel. For ease of handling by one man in renewal the cylinder sections are limited in weight to a maximum of 30 lb. each and are also interchangeable in all dimensions. To renew the cylindrical sections it is simply necessary to slide off and on the mandrel; the latter always remaining rigid in position and concentric with the circular aperture in the side plates. In order to expose a fresh wearing surface to the impact of the material being reduced the mandrel is given a slight turn with a spanner. By this means the cylindrical liner material can practically be all utilised doing useful work. The casing is opened out for inspection and changing of hammers by manipulating the right and left-hand screw at the top of the casing. The side wearing plates are sectionalised and also limited to a maximum weight of 30 lb. and are securely fastened to the casing plates. These also are made from special metal with high abrasive-resisting properties. The rotor discs are of cast steel mounted on a high-tensile steel shaft running in roller bearings. The hammer assembly is also an unorthodox patented feature of this machine, and comprises a manganese steel hammer holder to which are secured sectionalised laminated manganese steel hammer plates, interchangeable in all their dimensions.

By this method of construction it has been proved possible to use up practically all the metal for doing useful work, inasmuch that only a few ounces of metal are left over as scrap. Moreover, by this means the effective weight of the hammer remains practically constant, which is a highly important factor in efficient reduction of stone and minerals. The proportion of rejects in production is permanently maintained by the means provided for adjustment of the relative positions of the hammer tips and peripheral anvil wall. Means are provided in this machine for changing over from swing to fixed hammers as desired and in a few minutes. The machine is made in five sizes with outputs from 5 to 60 tons per hour.



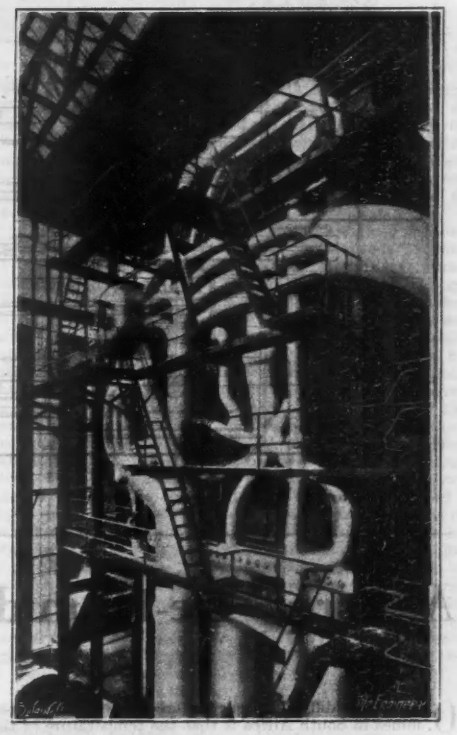
DESIGN OF IMPACT BREAKER AND GRANULATOR

English Insulation in Holland.

WE have recently had our attention attracted to an unusually fine job of heat insulating carried out in Holland by the Chemical and Insulating Company, Ltd., of Darlington. We reproduce a photograph illustrating part of the installation, which shows how elaborately the work was carried out.

The contract, which was secured in competition with Continental firms, called for the insulation of the piping in connection with the Babcock boilers, the pulverised fuel plant, and part of the turbine steam range. The steam pressure is 555 lb. per square inch saturated, and the specification called for insulation that would reduce the heat loss to not more than 0·5 calories per square metre per degree Centigrade of temperature difference. The contract called for over 100 tons of material, and was carried out by the maker's local agent, Monsieur N. V. Weber, of Haringvliet 91c, Rotterdam.

The materials used were 85 per cent. magnesia slabs and Darlington 85 per cent. magnesia plastic, together with considerable quantities of Dextramite high-temperature material. The maximum temperature encountered was 850 deg. Fah., which is the temperature of the superheated steam, and these conditions were taken care of by



BOILER INSULATION

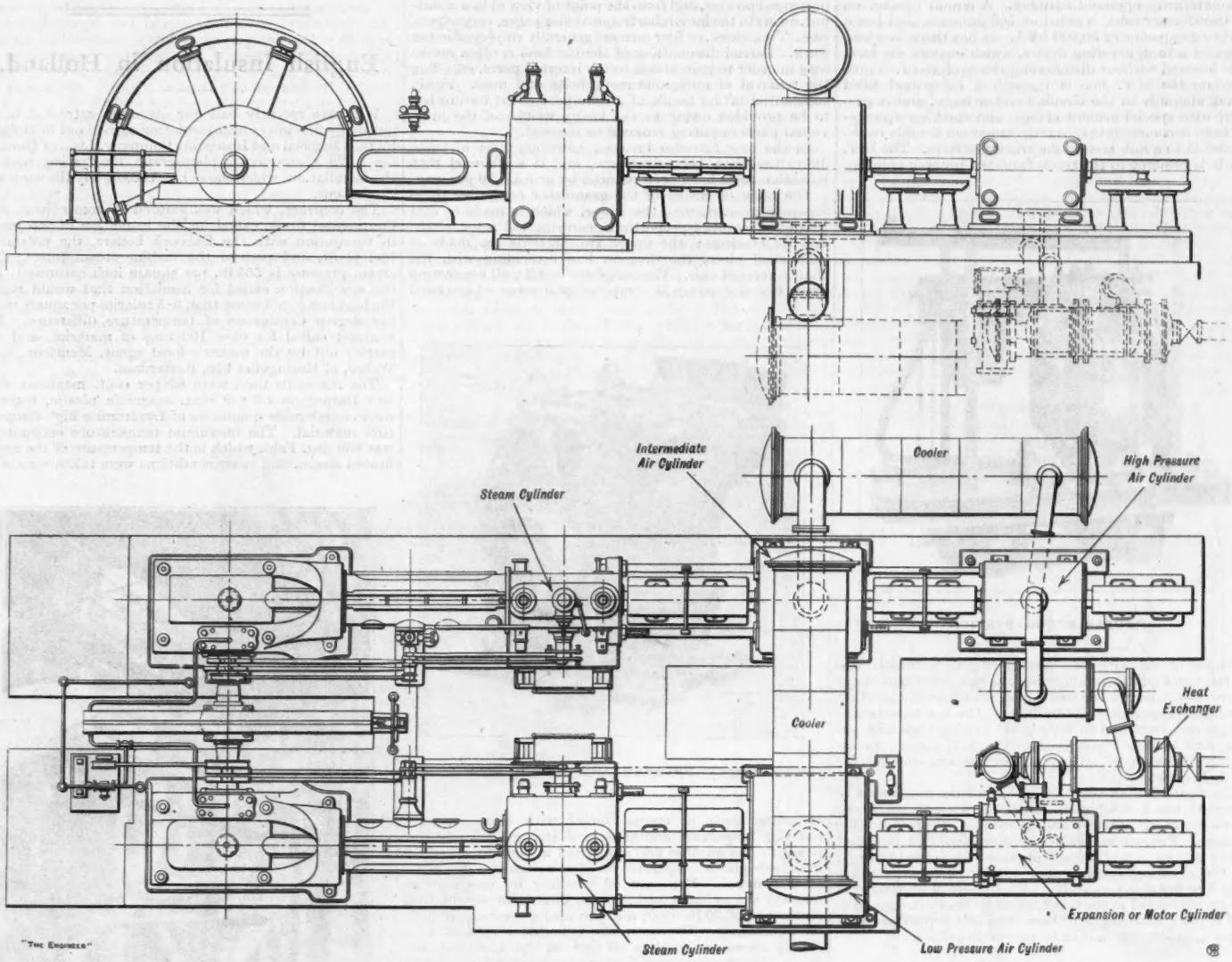
the adoption of 1in. Dextramite high-temperature plastic, followed by Darlington 85 per cent. magnesia plastic sewn in asbestos cloth. All other surfaces where the temperature ranged over 500 deg. Fah. down to 300 deg. Fah. were insulated with Darlington 85 per cent. magnesia plastic alone, without the adoption of a first coating of Dextramite high-temperature plastic, this high temperature material not being necessary at temperatures less than 650 deg. Fah.

Our illustration shows the lagging of the main steam pipes and that of the headers and riser pipes in connection with the Bailey water walls of the boiler furnaces. At the bottom of the illustration may be seen part of the Bailey wall lagging, which was carried out on the maker's panel system. There was first applied a coating of Dextramite high-temperature plastic, followed by a coating of 85 per cent. magnesia plastic, in which there was embedded a layer of Darlington 85 per cent. magnesia blocks. A second layer of similar blocks was then placed, breaking joint with those below, and finished with a casing of asbestos wood panels secured by banding. Besides the steam piping the hot air ducts in connection with the pulverised fuel burning plant were covered with insulating material.

MASTER TOOLS.—We have received from the Rawlplug Company, Ltd., Rawlplug House, Cromwell-road, London, S.W.7, particulars of its series of "Master" tools, which includes an adjustable spanner, a fixed ratchet spanner, and a pipe wrench. The adjustable spanner was described in THE ENGINEER of October 26th, 1934. The fixed ratchet spanner is similar in form to the usual fixed spanner, except that one of the jaws is shortened and the other specially curved. This arrangement permits the jaws to slide round the nut in one direction, but when turned the other way a cam action is obtained, and the jaws automatically grip. The pipe wrench is in appearance similar to an adjustable spanner, and the jaws, which are renewable and made of chrome molybdenum steel, have a capacity of ½in. to 2¾in. The overall length of the tool is 19in.

10,000 CUBIC FOOT STEAM-DRIVEN AIR COMPRESSOR

WALKER BROTHERS (WIGAN) LTD., ENGINEERS



A Large De-Humidifier Air Compressor.

ONE of the difficulties encountered in working certain mines in South Africa is that the temperature of the workings is high enough definitely to depreciate the abilities of the miners. Actually, as is now known, that is not a full statement of the conditions, for in certain coalmines in this country temperatures just as high are encountered, whilst the effect on the ability of the miners has not been so noticeable as to attract any great attention. The real difference in the conditions lies in the fact that in the South African mines concerned the high temperature is combined with a humid atmosphere, for, in order to keep down the ravages of silicosis, it has been found necessary to lay the dust by the use of moisture. On account of the danger of silicosis, no reduction of the amount of water used for laying the dust can be considered, and, in consequence, engineers in many countries are keenly interested in devising some means of making conditions in the mines more tolerable. One solution is, of course, the introduction of cold ventilating air into the mine. The cooling plant necessary, however, is expensive, and if a more economical means could be devised it would be preferable, even if its effects were limited only to those parts of the mines in which the majority of the miners worked.

The machine illustrated on this page seems likely to provide a solution to the problem. It was supplied by Walker Brothers (Wigan), Ltd., to the Anglo-American Mining Corporation of South Africa to produce the compressed air for operating tools and other machinery in the mine workings, and is especially interesting for the fact that the air before being passed down the mine is de-humidified. The advantages gained by this action are that expansion of the air in the pneumatic tools and machinery can be carried a great deal further than usual without fear that troubles will be incurred from condensation or the formation of ice, and that the exhausted air is both dry and very cold. Thus, wherever pneumatic tools are being used, the miners operating them will be supplied with cool, dry air, the entrance of which into the mine, it should be noted, will also displace a corresponding quantity of warm, humid air from the workings. Although the cooling effect will be local, it will, it seems, be localised just at those points where most of the workmen are likely to be collected. The machine is also interesting in that the castings were produced by the use of the sodium carbonate process, devised by Imperial Chemical Industries and described later.

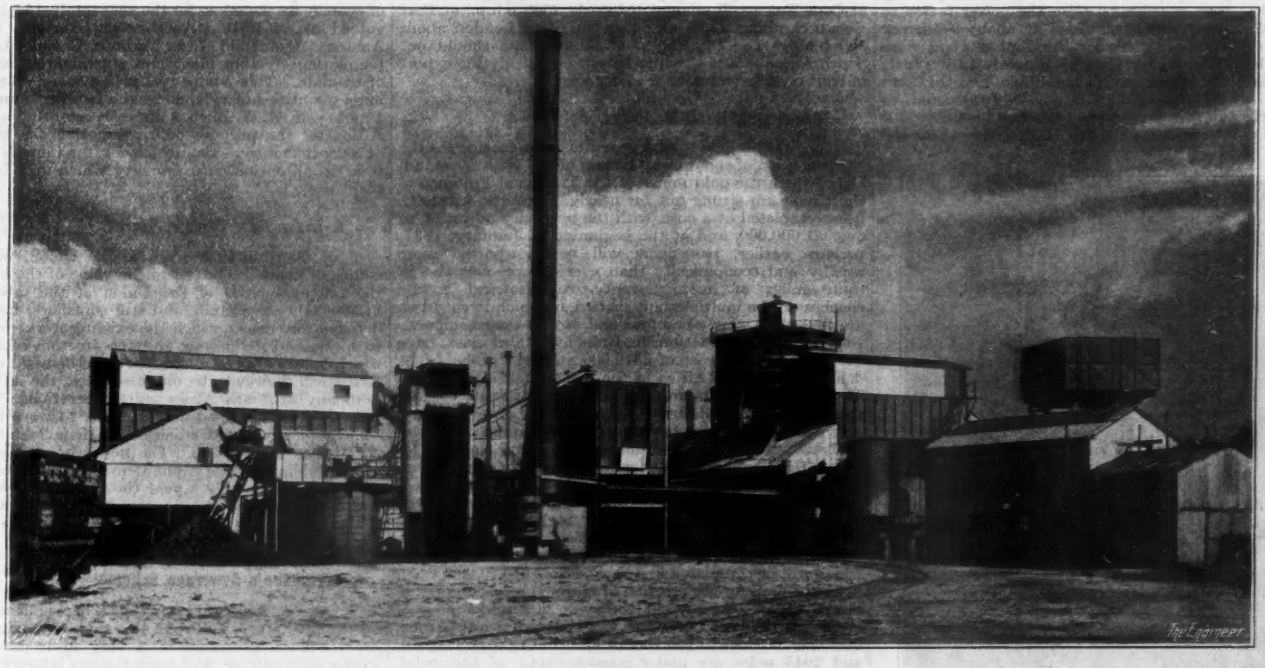
The air compressor is capable of deliverying 10,000 cubic feet of free air per minute, compressed and dried at 80 lb. per square inch gauge, and is driven by a steam engine, taking steam at 200 lb. per square inch pressure, with a superheat of 100 deg. Fah. As will be seen from the engraving at the head of this page and photographs reproduced on page 178, there is a two-throw crankshaft with the large fly-wheel disposed between the throws. The steam cylinders, 25in. and 52in. diameter respectively, and provided with Corliss exhaust valves, are placed nearest the crank shaft with the compressor cylinders further away. Compression of the air takes place in three stages, the cylinder diameters being 53in., 35in., and 24½in. respectively. Between each stage of compression the air passes through a cooler. The machine runs at 84 r.p.m., and has overall dimensions of 76ft. 6in. long, 21ft. 6in. wide, and 13ft. 9in. high. It weighs 250 tons. From the third stage compression the air is delivered at 130 lb. per square inch into an aftercooler, where it is cooled to as low a temperature as the cooling water temperature of about 85 deg. Fah. will permit. Condensate is separated out by baffles, and removed at suitable intervals. Thence the air passes through a heat exchanger, to be mentioned more fully later, in which further cooling and condensation occurs, and travels on to an expansion cylinder in which it is expanded and does work putting back energy into the compressor. Matters are so governed that its temperature at exhaust from this cylinder is about 32 deg. Fah., and never below that figure, while its pressure is about 85 lb. per square inch and never below 80 lb. per square inch. Resulting condensate is separated out, and the air passes into the heat exchanger already mentioned. Here it is warmed again, as it takes heat from the air travelling towards the expansion cylinders, and it is finally delivered to the mine workings at a temperature between 70 deg. and 80 deg. Fah. The governing device for the final temperature in the expansion cylinder consists of thermostatic control of the cut-off.

Naturally over-compression of the air and its subsequent re-expansion to the final delivery pressure results in a loss of overall efficiency. In fact, to produce the same quantity of de-humidified air, 10 per cent. more power must be expended in a machine like that described than in a straightforward compressor. It has, it is said, been determined, however, that 54 cubic feet of de-humidified air will perform as much useful work as 100 cubic feet of ordinary compressed air, so that in actual fact there is a considerable economy, not only of power, but also of initial capital cost. The following table gives some collected dimensions of the machine :—

Delivery	10,000 cubic feet free air per minute
Delivery pressure	80 lb. per square inch gauge
Steam conditions	200 lb. per square inch 100 deg. Fah. superheat
Steam cylinders	25in. and 52in. dia.
Air cylinders	53in., 35in., and 24½in. dia.
Expansion cylinder	17in. dia.
Stroke	4ft. 6in.
Speed	84 r.p.m.
Piston speed	756ft. per minute
Fly-wheel—	
Weight	26 tons
Diameter	20ft.
Overall dimensions—	
Length	76ft. 6in.
Breadth	21ft. 6in.
Height	13ft. 9in.
Total weight	250 tons

Mention has already been made that the castings for the compressor were made by the sodium carbonate process and some impression of the quality of the metal produced can be gained from the half-tone engravings. Walker Brothers (Wigan), Ltd., first got into touch with Imperial Chemical Industries, Ltd., with reference to the process shortly before making a number of castings for the Mersey Tunnel ventilating plant. Experience with those castings was so satisfactory that it was decided to adopt the process for the whole 250 tons of castings in the compressor under description. The firm states that only 5 cwt. of "wasters" were produced. In the sodium carbonate process a mixture of the granular salt and ground limestone in the proportion of 2 : 1 is used, and 30 lb. are added to each ton of molten iron in the ladle while tapping is in progress. No other change in foundry practice is required. When sodium carbonate is brought into contact with molten iron, it breaks up into two parts, oxide of sodium and carbon dioxide gas. The oxide has a powerful affinity for sulphur, with which it combines and then, rising to the surface, is absorbed by the slag. As much as half the sulphur in the metal, it is claimed, is thus removed, while what remains is more evenly distributed in the metal, and segregation thus avoided. Meanwhile, the carbon dioxide bubbles up through the metal, and in so doing agitates and degasifies it. Moreover, by this means the soda slag is brought into intimate contact with entrained particles of oxide and silicate, assisting their flotation and subsequent absorption by the slag. The process can also be used in steel-making and steel casting, and also finds certain applications in non-ferrous casting.

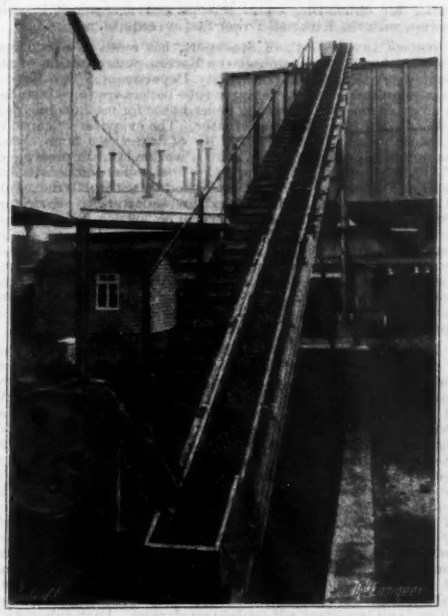
THE PLANT OF THE NATIONAL COKE AND OIL COMPANY, LTD., AT TIPTON, STAFFS.



Electrical Equipment at the National Coke and Oil Company's Works.

THE new plant of the National Coke and Oil Company, Ltd., at Tipton, Staffs., is the result of 5½ years' research and development work relating to the production of oil from coal and costing over £300,000. An experimental plant was first built at Cannock to enable the process to be perfected, the products tested, and the costs checked. It was then dismantled and a new plant with double the original output and incorporating improvements shown by the experiments to be desirable was erected at Tipton. With the exception of the refinery, in which steam plant has been installed, electric power is used throughout.

The raw materials are coal and creosote in the proportions of 93 and 7 per cent. respectively. Finished saleable products are a high-grade motor spirit, known as "Napet,"



CONVEYOR FOR "NACO" BRIQUETTES

a smokeless fuel, known as "Naco," and a heavy oil, which, although at present returned to the plant and used in the process, may, if market considerations make it desirable, be converted to fuel oil. Over 15 gallons of "Napet" are produced per ton of coal. The smokeless fuel "Naco" is in graded sizes and in the shape of small, hard, ovoid blocks. Production of this is about 15·6 cwt. per ton of coal.

Coal is received from trucks and passed through a screen into a conveyor, which carries it to the bunkers. It is then distributed to feeders above electrically driven pulverisers, which reduce it to a very fine dust, to be intimately mixed with coal from the process and passed through slowly rotating retorts heated by the combustion of gases which are a by-product of the distillation process. Producer gas is, however, used for starting up the retorts.

From the retorts the volatile matter is drawn off, passed through a condenser and is treated in the refinery in which the motor spirit is produced. From the lower end of each retort the coke is taken and passed through screens, whilst the fines are carried to the briquetting plant and after being mixed with bitumen and steam heated are pressed into ovoid shape. They are then taken on a wire conveyor to the bunkers ready for dispatch.

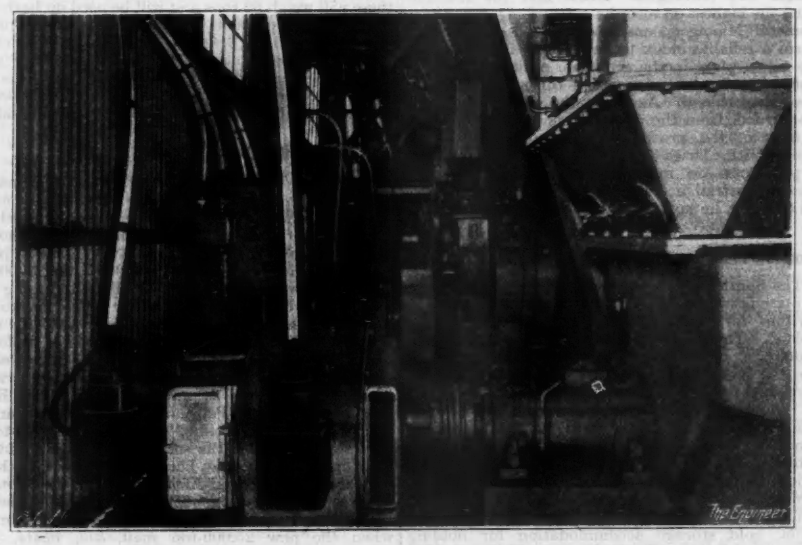
Two main factors determine the nature of the electrical plant, viz., the inevitable presence of large quantities of coal dust (necessitating extensive use of closed and pipe-ventilated motors, air filters, &c.) and the importance of absolute reliability. The process is a continuous one and it is essential that the retorts should not stop revolving while they are hot, since a stoppage lasting anything over a few minutes might cause serious damage.

The main supply is provided by the Midland Electric Corporation for Power Distribution, Ltd., at 7000 volts. There is, in addition, a standby supply at 2700 volts, and as the two circuits are fed from separate ring mains, continuity of supply under almost any circumstances is ensured. Two-phase incoming current is transformed to three-phase, 50-cycle, 400-volt current by Scott connected B.E.T. transformers rated in the case of the main supply at 700 kVA and 100 kVA in the case of the standby supply, which serves the retorts and lighting circuits only. Sixty yards of four-core P.I.L.C. steel-taped cable carry the current from the brick sub-station to the switchboard in the main works near the retorts.

The main distribution board built up of Crompton "Klad" units comprises the main standby supply switch, a change-over switch, two main supply switches, and eight feeders of 200 and 400 ampères capacity. If the main supply fails the change-over to the standby supply can be carried out in two minutes.

The largest drives are those of the pulverisers, retorts, and briquetting plant. Four 60 h.p. motors (two of the Crompton auto-synchronous type and two slip-ring motors) drive Alfred Herbert "Atritor" pulverisers, three through Texropes and one by a direct coupling. As the atmosphere surrounding these machines is necessarily heavily charged with fine coal dust, pipe-ventilated motors are employed. When the motors were actually installed, however, it was found difficult to arrange satisfactory runs for the ventilating pipes, and it was decided to provide "Visco" filters instead.

The retorts, which are 50ft. long and slightly inclined towards one end, are revolved slowly at speeds between 1 revolution per hour and 100 revolutions per minute, according to the nature of the charge and other factors. Power is provided by 15 h.p., 585 r.p.m. motors situated away from the coal dust in a culvert. The motors are directly coupled to oil pumps, which operate variable-speed gear units near the retorts. The final drive is by friction and good flexibility is secured. A 60 h.p. Crompton auto-synchronous motor in the briquetting shop drives the various machines through belts. The majority of the other motors drive the extensive conveyor system and suction fans and pumps. In all fifty motors, totalling about 600 h.p., are installed and with a few exceptions they were manufactured by Crompton Parkinson, Ltd. As experience has indicated that the firm's "Klosd" type motors are to all intents and purposes impervious to the finest and most abrasive dust, they are employed on an extensive scale. As the various materials are handled either by electrically driven conveyors or in the case of coal dust by suction fans and blowers, the plant works with very little labour. Only in the refinery in which the motor spirit is produced is steam used instead of electricity, which would have necessitated the use of explosion proof motors and switchgear. After taking into account the need for a certain amount of process steam, it was decided that in this case steam plant would be as satisfactory as electric plant and cheaper in first cost.

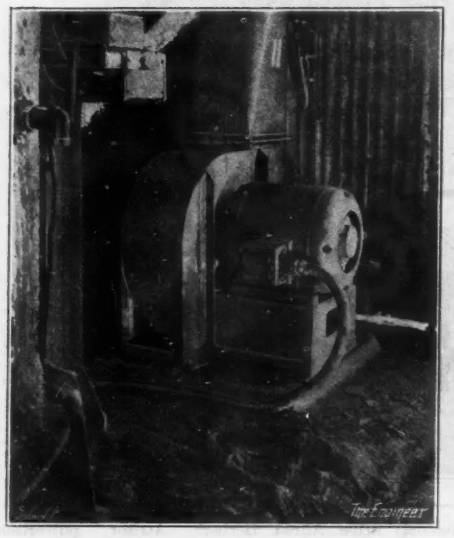


60 H.P. MOTORS DRIVING COAL PULVERISERS

Under the direction of Mr. G. Morris, the electrical engineer, all the electrical equipment was installed by the National Coke and Oil Company's staff. An interesting feature of the installation is the use for lighting as well as for power of wire armoured cables instead of cables in conduits. This is said to have made the work of wiring more simple than it would otherwise have been and to have saved time. Two men are said to have wired no fewer than twenty-five lights in 4½ days.

To the Midland Electric Corporation for Power Distri-

bution, Ltd., the load is a valuable asset. Apart from the fact that it extends over the twenty-four-hour day, by employing three 60 h.p. Crompton auto-synchronous motors—two on the pulverisers and one on the briquetting plant—it has been possible to raise the power factor to about 0·95 and current is obtained at about 0·4d. per unit. The main contractors for the Tipton plant were the Horseley Bridge and Thomas Piggott, Ltd. It is the first plant of a chain the National Coke and Oil Company proposes to establish in the near future and to which supply authorities concerned can look for a desirable load. The plant can deal with 300 tons per day of coal-oil



MOTOR-DRIVEN FAN

mixture and has been designed as a standard unit suitable for the erection by a colliery company for the conversion on the spot of its coal to motor spirit and smokeless fuel. Exclusive of land, the cost is stated to be about £40,000.

Acknowledgments are due to the officials of the National Coke and Oil Company, Ltd., for its help in the preparation of this article, and for making available the photographs reproduced.

South African Engineering Notes.

(By our South African Correspondent.)

CAPE TOWN, January 17th.

Record Year on Railways.

THE great expansion in trade and industry which has taken place in the Union as a result of the intense activity of the Transvaal gold mines, and the much higher price obtainable for their outputs, is reflected in the annual report of the General Manager of Railways and Harbours for the year ended March 31st, 1935. The report shows that the finances of the railways and harbours have once more been placed on a thoroughly sound footing. The year 1934–35 was one of great prosperity for the State transport services in South Africa. During the year 1934–35 railway traffic increased to a phenomenal extent. The tonnage and passengers carried and the revenue earned were the highest on record.

The General Manager considers that these financial results form a reliable index to the steady improvement which has taken place in the economic position of South Africa, following the long depression through which the country recently passed. As far as the current financial year is concerned, from the point of view of railway and harbour finance, the prospects are good. The trade outlook in South Africa continues to be favourable, farming prospects are more promising, and building, mining and industrial activity is still on a satisfactory level, and the year, he says, should close with a substantial surplus.

Precooling Plant for Cape Town Docks.

The South African Railways and Harbours have recently placed two more very important contracts in Great Britain for the supply of extensive fruit precooling plant. There had for some time been talk of a new precooling station being built at Cape Town, partly owing to the volume of fruit exports exceeding the capacity of the station and partly owing to the East Pier, on which the present building stands, having now become unsuitable owing to the recent additions to the Union-Castle fleet. It was therefore decided to build a new precooling station on the extension at C berth, in the New Basin, where all the large liners will be berthed as soon as the accommodation now being provided is ready. This station will finally have a capacity of 3750 cubic tons, and, in addition, cold storage accommodation for holding already precooled fruit pending shipment will be provided at No. 4 Shed, South Arm, first floor, to the extent of 1000 cubic tons, and at the Knuckle Berth, New Basin. The machinery and equipment for the whole of this scheme will embody, firstly, an extensive new plant, and secondly, the transferring of the existing plant from East Pier to C berth. All the equipment at East Pier was supplied by J. and E. Hall, Ltd., of Dartford, and this firm has again been selected to carry out the contract for the supply of the new machinery. A further plant has been decided upon by the S.A.R. and H. for Port Elizabeth. This precooling station will consist of an entirely new building with a capacity of 4000 cubic tons and will be used for precooling both citrus and deciduous fruit, the greater part being citrus. Here again the contract has been given to J. and E. Hall, Ltd., who are at present completing a similar, but smaller, installation at East London. An idea of the magnitude of the undertakings can be obtained from the figures for electric motor powers; taking the motors for refrigerating plant only, the aggregate power at Cape Town will amount to nearly 2500 b.h.p., at Port Elizabeth about 1700 b.h.p., and at East London about 520 b.h.p. The completion of these plants should put South Africa in a position to handle effectively the export of fruit on a large scale for many years.

Electrifying Rand Railways.

Within less than a year the great scheme for the electrification of the railway system of the Witwatersrand, along which the gold mines of the Transvaal Province of the Union are strung out for nearly 100 miles, will have been completed at a cost, with the necessary adjuncts, of over £1,000,000, and at the beginning of January, 1937, perhaps earlier, passengers will be transported more rapidly and economically than ever before over the 82 route miles of line. Seventy-two electrical motor coaches on the multiple-unit system, of which twenty-two are first class, thirty-one first and second-class composite with van accommodation, and nineteen third class, have been bought at a cost of £540,000 and will probably be delivered in South Africa in the second half of this year. The necessary alterations to the existing ordinary coaches will cost a further £450,000. The purchase of seventy-two new coaches will save buying, at an approximate cost of £250,000, seventy-nine ordinary suburban coaches for use on the Reef lines had steam working been continued. To provide facilities on the north side of the Bramfontein yard, which is the site of the running and inspection sheds and sidings for the electric rolling stock, houses occuping that site are having to be demolished. Meanwhile sufficient space has been cleared for the electric running shed, which will be completed in July at a cost of £70,000, when it will be used for the erection of motor coaches ordered in South Africa. At present there are 302 route miles of electrified railways opened in the Union of South Africa, of which 200 miles are on the Natal main line from Durban, and 204¼ miles are under construction; of this total, 123 miles are on the Durban-Volksrust line and the remainder on the Rand. Apart from the electrification scheme on the Rand, the Railway Administration is relieving congestion in the shortest possible time and coping with the steadily increasing traffic resulting from the extensive gold mining and industrial development by track alterations as well as providing additional tracks and other facilities. The first of the additional twenty-eight electric locomotives for the Natal system were recently landed at Durban (on Monday, January 6th). These twenty-eight units will cost altogether £345,000 and are to supplement the ninety-five units now operating. The additional units are necessary owing to the extension of electrified working in Natal, south from Cato Ridge to Durban and north from Glencoe to Volksrust. Both of these sections are expected to be electrified before the end of the year.

S.A.R. Scrapping Obsolete Engines.

In accordance with the recommendation of the Railway and Harbour Affairs Commission, the engine position of the S.A. railways was recently reviewed and approval given to the scrapping, over a period of years, of a number of obsolete engines, practically all of which have completed a theoretical life of 33½ years. In the first instance some 200 locomotives will be withdrawn from service in the course of a year or so. The heavier types will mostly be replaced by modern locomotives released from those sections shortly to be converted to electric traction—the electrification of the 80 route miles of the Witwatersrand system is to be completed before the end of 1936—and in so far as the lighter types are concerned, these will be replaced by new locomotives of suitable and improved design. Included among the latter will be two Diesel-electric shunting locomotives. One of these will weigh 60 tons and will be used on harbour work, where curves of 200ft. radius require to be negotiated. The other will be a 36-ton three-axled unit, capable of negotiating 280ft. curves, and is intended for use in up country mechanical and stores yards. Both locomotives are for experimental purposes; hence the decision to employ one at coastal and the other at a high altitude.

New Union-Castle Liners.

Mr. Robertson Fyffe Gibb, chairman of the Union-Castle and Bullard King Lines, who is now in the Union on a visit, stated in an interview that, although the Union-Castle Company had no immediate plans for new ships, its building programme on which it had just spent, or is spending, between £4,000,000 and £5,000,000, was not complete. It had not decided on anything concrete, but it would have to add further new ships to the fleet before very long. Mr. Gibb also stated that the new ships already put on seemed to have created a traffic of their own. The Johannesburg Exhibition next year would give another fillip to trade and passenger traffic. He announced that the second 8500-ton Bullard King liner will be launched in February. The "Dunvegan Castle" and "Dunnotter Castle," the new 15,000-ton intermediates, will enter the service about the middle of this year, but it had not yet been decided whether they would be placed on the round-Africa run or on the South African intermediate service. The "Armadale Castle" and "Kenilworth Castle" will be withdrawn from service when the new 25,000-ton mail, &c., boats, "Stirling Castle" and "Athlone Castle," enter on the mail service in the next few months, and will probably be sold.

Cyanide Manufacture in the Transvaal.

It looks as if the Transvaal will have two companies manufacturing cyanide there before long. First, Imperial Chemical Industries, Ltd., which supplies a large proportion of the cyanide used in South Africa, investigated the possibility of manufacturing it on the Witwatersrand, and as the results of these investigations are favourable it has been decided, if they are confirmed in practice, that African Explosives and Industries, Ltd., shall undertake the manufacture of cyanide at its explosives factory at Modderfontein. A pilot plant with a capacity of 500 tons is to be erected to enable production to start in the earliest possible time and to make available at an early date the data necessary for the design and erection of a large-scale plant. In 1934 the value of cyanide imported was over £400,000 and the consumption of cyanide by the mines for the year totalled 17,287,493 lb., valued at £467,519. Another big concern, the North American Cyanamid, Ltd., Toronto, Canada, is also contemplating erecting plant and starting the manufacture of cyanide. This company has for some years supplied large quantities of cyanide to the mining industry in the Union. Mr. N. W. Buch, a director, recently visited South Africa for the purpose of investigating the advisability of a local factory. Before leaving for Canada Mr. Buch took up an option on a property which may become the plant site.

A Large New Cement Works.

The building boom in the Union, which for a couple of years has added to the value of the buildings in the principal cities of the Union at the rate of about £13,000,000 per annum, and still continues, has caused a demand for cement which the existing works were unable to meet, and extensions and the erection of new works which has taken place still leave the demand unsatisfied. Relief will, however, be obtained when the Atlas Cement Company of South Africa starts operations. This company has been formed and is about to work a £325,000 cement plant erected adjacent to Henneman Station, in the Orange Free State. The new company is launched as a subsidiary to the Alpha Cement, one of the largest in England. For nearly a year the imports of cement from overseas has been on a very large scale, and Italian steamers coming to Union ports have brought it as their main cargo.

Germiston's Sewerage Scheme.

The Germiston sewerage scheme has now entered on the final stage, and soon this rapidly expanding Rand town will be possessed of a very up-to-date sewerage works, adequate to deal with a much larger outfall than at present. From early in January the work of connecting up houses and buildings in the greater part of the town was started and the whole scheme will be complete within the next three or four months. To bring the sewerage scheme into operation all that will be necessary will be to bridge the gap between the Germiston and Boksburg main outfall sewers, which will connect at a point below the Cinderella Dam, about 4 miles from Germiston and 3 miles from Boksburg. The sewerage scheme was estimated to cost £423,000, but the final cost will be a little over £500,000.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

THE PARSONS OIL ENGINE COMPANY, Ltd., Southampton, has in execution an order for six 50 h.p. petrol engines for the Drewry Car Company, to be used in light locomotives for one of the Overseas Dominions.

F. W. BRACKETT AND CO., Ltd., Colchester, inform us that the Leeds City Council has approved the acceptance of their tender for circulating water screens and accessories in connection with the Kirkstall Power Station extensions.

SIMON-CARVES, Ltd., of Stockport, has received a contract for a further big extension at the Barton power station of the Manchester Corporation Electricity Department. Two Simon-Carves multiple-drum-type water-tube boilers are to be installed in an extension of the existing boiler-house for use in connection with the new No. 5 turbo-alternator. The evaporative capacity of each boiler is to be 200,000 lb. of water per hour actual maximum continuous rating, with a working steam pressure of 375 lb. per square inch gauge, and a final steam temperature of 855 deg. Fah., which will be controlled to within 10 deg. Fah. of this figure at all ratings from three-quarters to maximum. The temperature of the feed water will be 300 deg. Fah. Simon-Carves water-wall combustion chambers and water-cooled suspended arches will be installed, and the boilers will be fired by means of Usco chain grate stokers. Messrs. Simon-Carves' contract also includes economisers, rotary air heaters, induced draught, forced draught and secondary air fans with vane control, superheaters, etc. The total value of the contract is approximately £137,000.

BRUCE PEEBLES AND CO., Ltd., Edinburgh, have received a contract for twenty-seven rectifier sub-station equipments for the Portsmouth main line electrification extension of the Southern Railway Company. The contract represents 67,500 kW of rectifiers—stated to be the largest ever placed in Great Britain—and is similar in nature to previous orders received for eighteen sub-station equipments for the London–Brighton–West Worthing extension, opened in January, 1933, and twenty-four equipments for the Eastbourne–Lewes–Hastings and Sevenoaks extensions, inaugurated in July of last year. The contract covers the manufacture, supply, and complete erection of twenty-seven 2500 kW "Peebles-Brown-Boveri" steel-cylinder, mercury-arc rectifiers, with main transformer, auxiliary transformers, recooler equipments, control panels, and accessories. Each rectifier will be designed for a normal D.C. output of 2500 kW at 660 volts, with overloads up to 8000 kW, and will operate in conjunction with a 33,000-volt, three-phase, 50-cycle oil-immersed self-cooled transformer. Each sub-station equipment will be completely automatic in its operation, once the main circuits have been operated by remote control.

THE ENGLISH ELECTRIC COMPANY has recently received the following contracts:—From the Director General, India Store Department: A contract for the supply and installation at Malakand power-house, in the North-West Frontier Province of India, of two 4500 h.p. horizontal reaction water turbines with 3200 kW, three-phase alternators, pipelines, and valves. Malakand power-house is situated on the West Bank of Dargai Nullah, immediately beneath Malakand Fort, and forms the first part of the Malakand hydro-electric development, which may reach an aggregate of 20,000 kW in future years. The turbines will be designed for a head of 243ft. and will run at 600 r.p.m. The generators will be designed for 11,000 volts, 50 cycles. The pipelines will be supplied by Stewarts and Lloyds, Ltd., under a sub-contract. From Henry Boot (Garden Estates), Ltd.: Diesel generating plant for installation at the Pinewood Studios, Iver, Buckinghamshire. The plant will comprise three 750 b.h.p. engines, each direct coupled to a D.C. generator, having an output of 450 kW, 240 volts, at 375 r.p.m.; one 300 b.h.p. engine direct coupled to a generator having an output of 200 kW, 240 volts, at 600 r.p.m. The main engines will be fitted with exhaust waste-heat boilers.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Iron and Steel Price Movements.

The general tendency for prices to advance has been illustrated by two important movements. Last week the hematite iron producers decided to advance their prices by 3s. to 5s. per ton. The increase, however, was not universally observed, the explanation being that the advance was not official. It was understood that whilst the increase had been agreed to by the hematite makers' association it had not been officially approved by the British Iron and Steel Federation. The fact that most firms charged the higher rates, however, indicated that little doubt was felt that its approval would be forthcoming. It is interesting to note that a few weeks ago it was reported that the hematite makers wished to raise their prices, but that the consent of the Federation was withheld. Another important announcement made towards the end of last week was that the British Iron and Steel Federation, the Continental Steel Cartel, and the South African Iron and Steel Corporation, of Pretoria (the latter representing the iron and steel producers of South Africa), had reached an agreement regarding the South African market. A few weeks ago the South African steel industry surprised the British steel makers and the Cartel by proposing an arrangement by which the British and Continental makers would accept quotas for South Africa equivalent to that part of the South African demand which the home industry was unable to satisfy. The South African Iron and Steel Corporation is practically State supported, and it was believed that the South African Government had turned a sympathetic ear to the representations of its steel makers that the importation of Continental steel at cheap prices was hindering the development of the industry. It has not been decided by what method the exports of British and Continental steel to South Africa will be controlled, but it is anticipated that the British Iron and Steel Corporation and the Cartel's selling organisations will undertake this work. Quotas will be based upon the 1934 export figures, which are more favourable to the British makers than to the Continental. As a result of this agreement Continental f.o.b. prices to ports in the Union of South Africa have been advanced as follows :—Bars, angles, and tees, 11s. 8d. gold to £3 11s. 8d. (£6 paper); plates, 2s. 6d. gold to £4 5s. (£7 2s. 6d. paper); joists, B.S., 11s. 2d. gold to £3 11s. 8d. (£6 paper). This week meetings of representatives of the British and Continental steel makers are to be held in London, at which, it is expected, important decisions will be reached.

British Iron and Steel Production.

In its monthly report for January, the British Iron and Steel Federation states that the production of pig iron during the month totalled 595,500 tons, compared with 559,300 tons in December, and 521,200 tons in January, 1935. The output includes 125,200 tons of hematite, 337,900 tons of basic, 105,100 tons of foundry, and 9800 tons of forge pig iron. The production of steel ingots and castings reached 912,500 tons, against 811,500 tons in December and 757,800 tons in January last year. At the end of January 109 furnaces were in blast, compared with 102 at the beginning of the month. The report does not give particulars, but the furnaces blown in were at the following works :—The Appleby Iron Company, Ltd., Frodingham (1); Colvilles, Ltd. (2); Guest Keen Baldwins Iron and Steel Company, Ltd. (1); Stewarts and Lloyds, Ltd., Bilston (1); Gjers, Mills and Co., Ltd. (1); and the Wellingborough Iron Company, Ltd. (1). The following table gives the average monthly production of pig iron and steel over a period of years and the production for the past four months :—

	Pig iron. Tons.	Steel. Tons.
1913—Monthly average	855,000	638,600
1920	669,500	755,600
1929	632,400	803,000
1933	344,700	585,300
1934	497,400	737,500
1935	535,500	820,200
October	544,300	907,300
November	529,500	903,300
December	559,300	811,500
1936—January	595,500	912,500

The Pig Iron Market.

The most interesting development in the pig iron market during the past week has been the increase in the price of hematite by 3s. per ton. Although this did not take the market by surprise, some doubt was felt previous to the meeting of the producers as to whether an advance would be decided upon. For the past two months the makers have been dissatisfied with their selling prices, but it has been generally understood that the authorities have been averse to a rise in prices. Some confusion, however, appeared to exist for several days after the producers' meeting, and whilst some makers believed the advance was not official and delayed putting it into operation, others raised their prices at once. It is suggested that now the makers are assured of a more profitable price, an expansion in the production of hematite iron on the North-East Coast will take place. For some time the makers have limited their commitments, and consumers have at times been unable to obtain all the iron they required. Quotations are now, for No. 1 quality, 77s. d/d North-Eastern area and Scotland. The situation in the Cleveland foundry iron market is unaltered, and no changes have been made in prices. One explanation of the scarcity of this make is that owing to the heavy requirements of the steel works, the producers are devoting their attention to the production of basic iron. Considerable quantities of foundry iron are passing into consumption against old contracts, but buyers who wish to place new business are only able to obtain odd parcels, and no export transactions have been reported. The Midland ironmasters also decided recently to make no immediate advance in prices, but the general opinion in the market seems to be that quotations will soon be raised. The position in the market, however, has been altered by the producers' decision to charge 5s. premium upon deliveries after June 30th next, and not to accept contracts for delivery after the end of this year. Most of the large consumers are well covered, but lately there has been a certain amount of business offering for delivery right up till December, although very little of this has matured, partly because the producers were disinclined to commit themselves so far ahead. The stocks of forge iron in the Midlands have been depleted by the recent demand, and it is not easy to obtain prompt delivery. In Scotland stringent conditions rule in the market for foundry iron.

The Midlands and South Wales.

In the Midland steel market business is active in practically every department. The call for billets is as vigorous as at any time during the past six months, but some relief has been afforded by the arrival of Continental material supplied by the British Iron and Steel Federation. The British steel works are unable to accept orders for billets now, as their outputs have been sold for months ahead, and most of them are behind with deliveries. The Continental material has been disposed of to consumers at £5 10s. d/d for 500-ton lots, 100 tons of a size, the same price as that quoted for British billets. The demand for sheet bars has broadened during the past few weeks, with the result that stringent conditions have developed in that market and quotations have increased from £5 10s. to £5 15s. A section of the market which has benefited from an improved demand lately has been the bar iron department. The movement has been chiefly noticeable in the better grade of iron products, but business in crown bars also has expanded. Strong pressure continues to be exerted by the constructional engineers to obtain supplies, but lately some steel makers have declined to quote for forward business at current prices. Business in steel sheets has been distinctly good, and whilst the home trade requirements have been well maintained, there has been some improvement in the call from overseas markets. A feature of the market in the Midlands has been the heavy call for small steel bars and strip. The recent release of about 10,000 tons of Continental merchant bars for the British market under the quota arrangement was quickly absorbed. The quotation for the sizes not included in the British steel makers' rebate scheme was advanced to £5 9s. paper, f.o.b., which works out at £7 12s. 6d. d/d Birmingham area. For sizes included in the rebate scheme the old price of £5 2s. 6d. f.o.b. was quoted. Cheerful conditions rule in the South Wales market, although the export demand for tin-plates is checked by the International Tin-plate agreement. An important Canadian order was secured recently by Welsh makers.

The North-East Coast and Yorkshire.

Satisfactory conditions rule on the North-East Coast and record outputs are being made. In December the total output of steel reached 191,100 tons, which was larger than for any previous month of 1935. The year's production on this coast totalled 2,061,300 tons, a figure which has not been exceeded since 1929. The position as regards semi-finished steel is still difficult in spite of importations of considerable quantities of Continental billets, and the works are struggling to overtake arrears in deliveries. Recent orders for ships in this district have resulted in a renewed demand for shipbuilding material, although the works were already in a position to maintain their present rate of output for some months. The structural engineers are busy, but the winter weather has interfered to some extent with work in the open air, and as a result specifications have not been reaching the steel works on quite the same scale as of late. There is, however, no real slackening in the demand for joists and sections. The possibility of a price increase has been discussed for some time, and the general view seems to be that it will not be long delayed. A considerable amount of work for the railways is on hand, and there is not likely to be any falling off in activity at the mills producing this class of material. The position at the sheet mills is not quite so good. Home requirements are on a good scale, but export business after a brief expansion has fallen rather flat. The business activity in the Yorkshire steel market has been well maintained, and some manufacturers express doubts as to whether the supplies of coke, pig iron, and other raw materials will be sufficient for the requirements of the industry if the present rate of operations is maintained. Business in basic billets seems to be increasing and delivery difficulties are being experienced by most consumers. Lately, there has been some improvement in the request for high-speed steel, but prices remain unaltered at the long-standing figure of 2s. per lb. for 14 per cent. and 2s. 9d. for 18 per cent. tungsten content. The aircraft industry is responsible for a large consumption of A.I.D. inspected steels, and the production of stainless steel bars, sheets, and strip appears to be steadily expanding. The Yorkshire bar iron makers are well employed, and a section of the industry would like to see an advance in prices.

Current Business.

Swan, Hunter and Wigham Richardson, Ltd., of Wallsend-on-Tyne, have secured a contract for two oil tank vessels of over 14,000 d.w. each from London owners. It is announced that Canadian Pacific Steamships, Ltd., will place an order on the Clyde within the next few months for a 42,500-ton liner for their Transatlantic service. The vessel will be a sister ship to the "Empress of Britain." Subject to the settlement of points of detail, the Admiralty will give contracts for the following vessels of the 1935 programme :—Mine-laying submarine H.M.S. "Cachalot," to Scott's Shipbuilding and Engineering Company, Ltd., Greenock; surveying ship H.M.S. "Gleaner" and sloop minesweeper H.M.S. "Hazard," to William Gray and Co., Ltd., West Hartlepool. Smith and McLean, Ltd., Glasgow, have started another rolling mill at their Mossend Works on the production of thin and medium plates. Richard Thomas and Co., Ltd., will shortly commence the manufacture at the Cwm-felin Works of fish crates made from steel sheets, and cases for beer bottles. Reports which have been circulated that the company intended to manufacture various utensils extensively made in the Birmingham district are inaccurate, and the crates and cases referred to are the only articles which will be produced. Dorman, Long and Co., Ltd., Middlesbrough, state that within the next two months three more furnaces will be put into blast, and two newly constructed furnaces will be blown in to replace two which will close down for repairs. The Department of Overseas Trade announces that the following contracts are open for tender :—South African Railways and Harbours : Grinding wheels (Johannesburg, March 2nd); Johannesburg, City Council : supply of steel water piping, sluice valves (Johannesburg, February 22nd); supply delivery and erection of plant required for a complete extension of gasworks (Johannesburg, March 21st). Lourenco Marques, Railway Administration : rails, fish-plates, switches, bolts, nuts, and coachscrews (Lourenco Marques, March 5th) Egyptian Ministry of Finance : fifty-five light railway wagons and sixty rope jockeys (Egypt, March 16th).

Copper and Tin.

The situation in the electrolytic copper market took a turn for the better at the end of last week following a period of quiet trading. Improved reports of the position in America were no doubt largely responsible, as it was the uncertainty and lack of confidence in the American market which was the chief cause of the decline in the demand. Italy and the Balkan States took fair quantities of the metal, although not so much as they would have assimilated had financial conditions been better. It was interesting to note also that the Soviet Government entered the market and bought about 2000 tons of electrolytic copper. In this country buying has been quiet, but it is expected that consumers will soon have to replenish their stocks. The exports of refined copper from America during December, excluding concentrates, totalled 19,546 tons, the total for 1935 being 260,922 tons. Business in the London standard market has fluctuated, and after a spell of activity has again become quieter. When prices were at their lowest level a certain amount of speculation developed, but this was not sufficient materially to affect prices. It is interesting to note that the German copper refineries have found it difficult to secure their full requirements of scrap, and as a consequence have bought good quantities of rough copper in this country. This has reduced the stocks in standard warehouse. In fact, for some months past the copper in warehouse has been declining at the rate of 2000 to 3000 tons per month. . . . The tin market has not presented any feature of interest, and there has been a tendency for prices to recede. There is still a scarcity of cash tin in the market, and last week premiums of £1 were paid to secure tin from London warehouse, much to the dissatisfaction of some consumers. The expected improvement in the demand from the United States fails to develop, although it is said that consumers in that country are not well covered. European requirements of tin, apart from Russia, are upon a poor scale. The Soviet purchases of late have been rather heavy, but it is suggested that buying from this quarter has ceased for the time being. Attention is being drawn to the small stocks of tin in this country, the quantities in London and Liverpool together totalling only about 900 tons. It is suggested that this almost approaches a national danger, and A. Strauss and Co., Ltd., in a review of the market, point out that "if a boat carrying a heavy cargo of ore from Bolivia should be lost, British tin-consuming industries might literally have to close down through lack of supplies."

Lead and Spelter.

Steady conditions have ruled in the lead market over the week, but trading has declined in volume and the confident feeling which was noticeable a few weeks ago seems to have disappeared. A certain amount of realisation by speculators has helped to depress prices, but it seems to be taken for granted that the greater proportion of the bull account which was built up a few weeks ago has been liquidated. Lately producers have again shown willingness to follow the market down, and in the absence of any buying pressure this has accentuated the weaker tone. The demand from consumers has been fairly well maintained considering the surrounding circumstances, but naturally there has been a fall in the consumption of manufactured lead products used by the building trade, as the operations of that industry have been seriously hampered by the wintry weather. The cable industry, however, is busy, and the battery makers report an improving demand. Reports from the Continent indicate quieter conditions, and this has been another factor contributing to the poor outlook in the market here. . . . The spelter market continues to present a colourless appearance, but prices have been fairly steady. Consumption in this country has been at a comparatively low level for some time, and lately the Continental demand has declined. In America, however, activity has been maintained, although the demand has not expanded in accordance with anticipations. The brass makers in most countries seem busy, but other consuming trades are not taking large quantities of the metal. According to American figures, the world's production of spelter in December was 130,285 tons, the total for 1935 being 1,465,209 tons.

Current Prices for Metals and Fuels.

Makers' official home trade prices per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. * For Markets other than Canada, India, South Africa, Australia and New Zealand 5s. per ton must be added.

PIG IRON.

	Home. (*D/d Teesside Area*) £ s. d.	Export. £ s. d.
N.E. COAST—		
Hematite Mixed Nos.	3 16 6	3 2 0
No. 1	3 17 0	3 3 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 12 6	3 4 0
No. 3 G.M.B.	3 10 0	3 1 6
No. 4 Forge	3 9 0	3 0 6
Basic (*Less 5/- rebate*)	3 10 0	—
MIDLANDS—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 15 0	—
" " Forge	3 10 0	—
Basic (*Less 5/- rebate*)	3 15 0	—
Northampton—		
Foundry No. 3	3 12 6	—
Forge	3 7 6	—
Derbyshire—		
No. 3 Foundry	3 15 0	—
Forge	3 10 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 17 0	—
No. 1 Foundry, ditto	3 16 6	—
No. 3 Foundry, ditto	3 14 0	—
Basic, d/d (*Less 5/- rebate*)	3 10 0	—
N.W. COAST— Hematite Mixed Nos.	3 17 0 d/d Glasgow; 4 2 6 " Sheffield; 4 8 6 " Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
LANCS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. YORKS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
MIDLANDS—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
No. 3 quality	7 17 6	—
No. 4 "	8 10 0	—
SCOTLAND—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. COAST—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

LONDON AND THE SOUTH—	Home. £ s. d.	Export. £ s. d.
Angles	8 10 0	*7 10 0
Tees	9 10 0	*8 10 0
Joists	8 17 6	*7 10 0
Channels	8 15 6	*7 15 0
Rounds, 3in. and up	9 10 0	*8 10 0
" under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¾in. (basis)	9 0 0	7 15 0
" ⅜in.	9 5 0	8 0 0
" ½in.	9 10 0	8 5 0
" ⅝in.	9 15 0	8 10 0
" ¾in.	9 10 0	9 0 0
NORTH-EAST COAST—	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	*8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
" under 3in.	8 12 0	7 10 0
Plates, ¾in.	8 15 0	7 15 0
" ⅜in.	9 0 0	8 0 0
" ½in.	9 5 0	8 5 0
" ⅝in.	9 10 0	8 10 0
" ¾in.	9 5 0	9 0 0
Boiler Plates, ¾in.	9 5 0	—
MIDLANDS, AND LEEDS AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	*8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
" under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
" ⅜in.	9 2 6	8 0 0
" ½in.	9 7 6	8 5 0
" ⅝in.	9 12 6	8 10 0
" ¾in.	9 5 0	9 0 0
Boiler Plates, ¾in.	9 7 6	7 15 0

STEEL (*continued*).

GLASGOW AND DISTRICT—	Home. £ s. d.	Export. £ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
" under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 15 0	7 15 0
" ⅜in.	9 0 0	8 0 0
" ½in.	9 5 0	8 5 0
" ⅝in.	9 10 0	8 10 0
" ¾in.	9 5 0	9 0 0
Boiler Plates	9 5 0	—
SOUTH WALES AREA—	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	*8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
" under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
" ⅜in.	9 2 6	8 0 0
" ½in.	9 7 6	8 5 0
" ⅝in.	9 12 6	8 10 0
" ¾in.	9 10 0	9 0 0

IRELAND—	BELFAST. £ s. d.	REST OF IRELAND. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
" under 3in.	9 2 0	9 4 6
Plates, ¾in. (basis)	9 0 0	9 2 6
" ⅜in.	9 5 0	9 7 6
" ½in.	9 10 0	9 12 6
" ⅝in.	9 15 0	9 17 6
" ¾in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G. to 13-G., f.o.r.	9 15 0	9 0 0
14-G. to 20-G., d/d	11 5 0	9 10 0
21-G. to 24-G., d/d	11 10 0	9 15 0
25-G. to 27-G., d/d	12 2 6	10 7 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24

Home.	£ s. d.
4-ton lots and up	13 10 0
2-ton to 4-ton lots	13 17 6
Under 2 tons	15 10 0

Export: £12 15s. 0d., c.i.f. India.
" £11 15s. 0d., f.o.b. other markets.
" Scandinavian Markets free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18s. 9d.
Tin-plate Bars, d/d South Wales Works, £5 10s. 0d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
" Medium (0·42% to 0·60% C.)	7 2 6
" Hard (0·61% to 0·85% C.)	7 12 6
" " (0·86% to 0·99% C.)	8 2 6
" " (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 to 250 tons	5 17 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
" Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/- per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/-
" " 6 p.c. to 8 p.c.	£21 0 0	7/-
" " 8 p.c. to 10 p.c.	£21 0 0	7/-
" " Specially Refined		
" " Max. 2 p.c. carbon	£33 10 0	11/-
" " " 1 p.c. carbon	£36 5 0	11/-
" " " 0·50 p.c. carbon	£37 5 0	12/-
" " " carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose), 76 p.c.	£10 15 0 home	
" Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/- p.u.	
" " 75 p.c.	£17 17 6 scale 6/- p.u.	
" Vanadium	12/8 per lb.	
" Molybdenum	4/6 per lb.	
" Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, February 12th.

COPPER—		
Cash	£35 1 3 to £35 2 6	
Three months	£35 8 9 to £35 10 0	
Electrolytic	£39 5 0 to £39 15 0	
Best Selected Ingots, d/d Birmingham	£39 10 0	
Sheets, Hot Rolled	£66 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10½d.	10½d.
" Brazed (basis)	10½d.	10½d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£32 0 0 to £33 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9½d.	9½d.
" Brazed	11½d.	11½d.
TIN—		
Cash	£208 15 0 to £209 0 0	
Three months	£201 5 0 to £202 0 0	
LEAD	£15 12 6 to £15 15 0	
SPELTER	£14 12 6 to £14 17 6	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

LANARKSHIRE—	Export.
(f.o.b. Grangemouth)—Navigation Unscreened	17/6 to 18/-
Hamilton Ell	20/- to 21/-
Navigation Splints	21/- to 22/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	17/- to 17/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	15/6
Unscreened Navigation	16/- to 16/6
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime	17/-
Secondary Steam	16/-

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	19/6 to 23/-
Furnace Coke	14/6 to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	15/6 to 16/-
" Second	14/6 to 15/-
" Best Small	11/- to 11/6
Unscreened	13/6 to 14/6
DURHAM—	
Best Gas	14/8 to 15/-
Foundry Coke	20/- to 23/-

SHEFFIELD—	Inland.
Best Hand-picked Branch	26/- to 28/-
South Yorkshire Best	23/- to 25/-
South Yorkshire Seconds	20/- to 21/-
Rough Slacks	11/- to 12/-
Nutty Slacks	10/- to 11/-

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	19/6
Best Seconds	19/- to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Bunker Smalls	12/6 to 13/6
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/- to 27/6
Foundry Coke	27/- to 40/-
Furnace Coke	19/- to 22/6
Patent Fuel	21/-
SWANSEA—	
Anthracite Coals:	
Best Large	36/- to 40/-
Machine-made Cobbles	41/- to 48/6
Nuts	40/- to 48/6
Beans	25/- to 35/-
Peas	19/- to 23/-
Rubbly Culm	11/6 to 12/-
Steam Coals:	
Large Ordinary	18/- to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

French Engineering Notes.

(From our own Correspondent in Paris.)

Coal Quotas.

An influential deputation from coal importers and consumers waited on the Minister of Public Works last week and explained to him the possible consequences of concessions which the British Government requires from France as a condition to the granting of a loan to the French Government. One of these concessions is that British coalowners shall have the right to supply coal up to their full quota to anyone they please. This, at least, is regarded as the British meaning of a demand for the substitution of "certificates of origin" for the present licensing system. Under this system British coalowners are placed at a disadvantage with regard to foreign competitors, in the sense that importers are dependent upon the Mines Department for British coal licences, while the allotments for other countries are in the hands of commissions representing importers and foreign coalowners. The result of this state of things is that importers of British coal are controlled by the Mines Department, which reserves a certain tonnage that may or may not be utilised according to circumstances. Moreover, the manipulation of the British quota is always embarrassing and frequently detrimental to British coalowners. Importers have the right to transfer to other countries 20 per cent. of the quantity allotted to them under licence for British coal, and this privilege is utilised as a means of keeping down prices by competitive offers from foreign producers. Another objection to the British demand is the belief that British coalowners will pass over importers and supply consumers direct, with the result, they say, that coal prices will advance. The British Government has long endeavoured to remove the harassing restrictions to which coalowners are subjected, but it has always encountered a force of inertia, and the demand now made aims at breaking down a discriminating system which is specially harmful to British interests. What the British Government claims is really nothing more than what the French Government proposed recently when it made a tentative suggestion to issue import licences to anyone requiring them on payment of a super tax. It was rejected by importers who enjoy a privilege under the licensing system and by consumers who regarded the super tax as an addition to the import duty on coal. The Government's action implies that it is disposed, in present circumstances, to grant the concession to British coalowners, and the ports and maritime interests would welcome an extension of trade in British coal.

Soundproof Materials.

Several months ago the French Touring Club promoted a competition of soundproof materials with a view to laying out a City of Silence at the Paris Exhibition next year. The samples of materials supplied were tested at the laboratory of the Conservatoire des Arts et Métiers, which selected ten out of 140 samples submitted as fulfilling rigid conditions of the test. Small rooms built with these ten materials are a feature of the annual exhibition of Arts Ménagers now being held in the Grand Palais. Insulation from sound was not to be obtained at the expense of other requirements in building materials, in particular insulation from outside temperatures, which, in the samples shown, seems to have accompanied naturally the devices employed for deadening sound. In most cases the problem is regarded as one of insulation by air, and in others the materials are light and porous, one highly compressed conglomerate containing a large percentage of straw. Another employs twin hollow bricks forming air chambers embedded in concrete. For partitions or for lining walls and insulating floors layers of plaster, bitumen, tarred asbestos, and sheet lead are compressed in slabs. The tests carried out on a small laboratory scale can hardly give more than an approximation to results obtained in actual building, but they eliminate hopeless competitors and leave others to work out the issue on a practical scale. In the laboratory tests hollow concrete of a given thickness suppressed sound by 43·25 decibels, and the reduction of sound through the successful materials ranged from 45 to 55 decibels. While the small number of successful competitors implies that the problem of fulfilling all the conditions imposed is an intricate one, and is dealt with more by intuition than by scientific methods, it appears that an encouraging start has been made, and the results obtained with the "City of Silence" in Paris will be awaited with interest.

Merchant Marine.

The latest returns of idle shipping at French ports continue to show a diminution, but they represent something like 14 per cent. of the total tonnage of the merchant fleet. The situation of the mercantile marine is still regarded as serious, and efforts are being made to ensure, during the next few months, the universal adoption at Geneva of the eight hours' working day, which shipowners declare is an intolerable burden to them so long as other countries fail to follow the lead taken by the French Government in 1919. At that time the eight hours' day was adopted provisionally in the French merchant marine pending its extension to other countries, but as this restriction of working hours on board ship was systematically opposed by foreign shipowners, attempts were made unsuccessfully, on two occasions, to suppress it in France. Having obtained a reduction of working hours without reduction of wages the men refused to relinquish their advantage, which shipowners affirm is largely responsible for unemployment in the merchant marine. There are further troubles arising out of labour unrest at the ports and shipyards. At Marseilles the dockers have again been on strike, and at the Penhoët yard at Saint-Nazaire the mechanics ceased work as a protest against a revised scale of wages. Work will be started at Saint-Nazaire at the earliest possible date on the new "Atlantique," which will be of 30,000 tons and will steam at 25 knots. The cost will, of course, be covered by the insurance money paid for the burnt-out "Atlantique," which was an experiment in elaborate equipment that will not be repeated. There is under consideration the construction of a second big liner for service between Marseilles and South America.

British Patent Specifications.

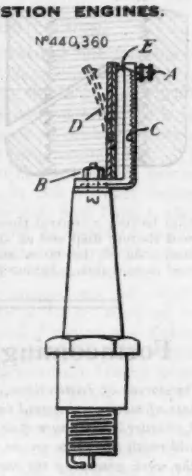
When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.



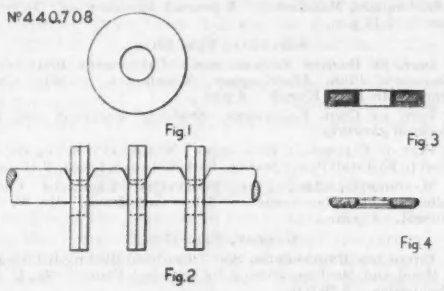
440,360. June 27th, 1934.—IGNITION SYSTEMS, Marconi's Wireless Telegraph Company, Ltd., Electra House, Victoria Embankment, London, W.C.2; and A. A. Linsell, 80, Crystal Palace Park-road, Sydenham, London, S.E.26.

The object of this ignition plug is to reduce interference with nearby radio sets. Between the terminal A and the electrode B of the plug there is inserted a suppressor resistance C. A path for the ignition current is also provided by the bimetallic strip D and contacts E. These contacts remain closed when the engine is cold and a strong spark is required, but open as the engine warms up and the suppressor resistance becomes effective.—*December 27th*, 1935.

TRANSFORMERS AND CONVERTERS.

440,708. June 7th, 1935.—THE MANUFACTURE OF ALTERNATING ELECTRIC CURRENT RECTIFIERS, *Westinghouse Brake and Signal Company, Ltd.*, 82, *York-road, King's Cross, London, N.*1.

This invention relates to the manufacture of alternating electric current rectifiers of the copper oxide type, the principal object being to provide a process for removing the thin high-resistance cupric oxide layer which is formed on the cuprous oxide layer during the oxidising process. The rectifier element is shown as formed from a copper blank of circular form with a central aperture. A number of these blanks are assembled on a suitable support in pairs in the manner shown in Fig. 2, so that the blanks of each pair have their adjacent faces in contact, and the blanks are then subjected to an oxidising process, such, for example, as the application of heat in an oxidising atmosphere to form an oxide coating. The oxidising process is continued until a sufficient deposit of oxide is formed over the exposed surfaces of the blanks. Each blank will then appear as shown in Fig. 3, from which it will be seen that the blank is now covered with an inner coating of cuprous oxide and a thin outer coating of cupric oxide. The flat face of the blank which is exposed during the oxidising process—that is to say, the lower face—has a much heavier oxide coating than the upper face. After the oxidisation is completed, the elements are cooled

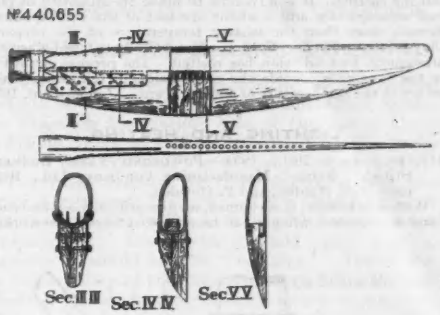


by quenching them in water, and they are then treated to remove the cupric oxide layer from the entire surface of the blank, and to remove the cuprous oxide coating from only one face. This treatment is a very critical stage in the manufacture of the completed rectifier elements. A weak solution of sulphuric acid and hydrochloric acid in distilled water is found particularly suitable for this purpose. The concentration of the acids in this solution is not critical, but a solution consisting of 2 per cent. by volume of sulphuric acid and 1 per cent. by volume of hydrochloric acid in distilled water is preferred. The temperature at which the solution is used is not critical, but the desired action of the solution is materially accelerated and elements having a higher resistance in the high resistance direction are produced if the solution is hot, preferably at a temperature of between 80 deg. and 100 deg. Cent. The elements are preferably immersed in the solution for a time interval, which is approximately twice as long as is required to remove the cupric oxide. After the elements have been immersed in the solution they are washed in water and thoroughly dried. The chemical treatment of the elements may also include immersing them for two or three seconds in concentrated nitric acid to remove any finely divided copper which may have been left on the elements by the previous chemical treatment, and to dissolve any loose or broken crystals remaining on the surface of the cuprous oxide.—*January 3rd*, 1936.

AERONAUTICS.

440,655. July 3rd, 1934.—AIR SCREWS, Sir W. G. Armstrong Whitworth Aircraft, Ltd., Sir J. Davenport Siddeley, and H. N. Wylie, Whitley, Coventry.

This invention relates to air screws such as have composite blades. The main object is to provide an improved air screw which will not be liable to flutter and will have high aerodynamic efficiency and be of low weight. In ordinary air screws the blades are liable to vibrate owing to rapid fluctuations of air pressure. In such vibration the blades bend mainly about axes in the direction of the width of the blade. The bending is usually accompanied by twistings which cause variations in pitch angle, and consequently in air pressure, and the fluctuation in pressure is liable to synchronise with the bending, so as to increase it. This gives rise to conditions of forced vibrations which cause rough running and subject the blade material to increased stress, and which in certain circumstances may be so pronounced as to amount to perceptible or even destructive "flutter" of the blades. It is known that the twisting of the blades is mainly due to inertia forces which oppose the sudden bending of the blade under a momentary increase in pressure, and oppose its spring back when the momentary increase of pressure abates, and which cause it to overshoot the mean position. The inertia forces on any short length of blade act through the centre of mass of that length, whereas the resistance of the blade to bending acts along what is known as the

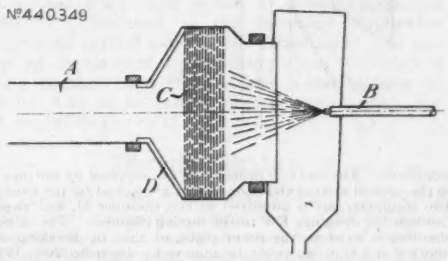


flexural axis. According to the invention, a composite blade consists of lengths of different materials, such as metal, on its leading and wooden trailing portions; and the arrangement may be such that the centre of mass of any short length of blade is close to or on the axis of flexure, and it may even be slightly forwardly thereof. Thus the twisting due to inertia can be reduced or eliminated, or caused to damp out vibrations that may have started. The illustration shows in elevation and sections the construction of such a blade.—*January 3rd*, 1936

FURNACES.

440,349. June 26th, 1934.—ROTARY CEMENT KILNS, M. Vogel-Jorgensen, 24, Bülowsvej, Frederiksberg, near Copenhagen, Denmark.

The cement slurry is dried before passing into the kiln A by

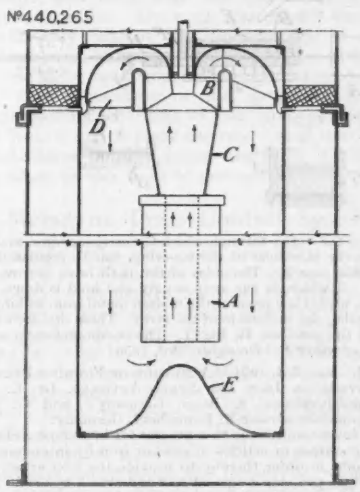


being projected from a nozzle B against a screen of chains C. These chains hang in an enlargement of the kiln which has a diameter greater than the axial length of the screen. The dried slurry is fed into the kiln by scoops D.—*December 27th*, 1935.

PUMPING AND BLOWING MACHINERY.

440,265. June 20th, 1934.—FANS FOR CIRCULATING AIR OR GASES, Electric Resistance Furnace Company, Ltd., and F. L. Yearron, 17, Victoria-street, London, S.W.1.

This fan is intended for circulating the gaseous contents of an electric furnace for the purpose of equalising the tempera-



ture of the object being heated—a gun tube A, for instance. The fan is driven by a motor—not shown—and has an open eye B, which is connected with the gun tube by the cone C. The vanes D propel the gases downward round the outside of the casing, and they are directed upward into the bore again by the dome E.—*December 20th*, 1935.

METALLURGY.

440,712. July 26th, 1935.—THE PRODUCTION OF LEAD-TELLURIUM ALLOYS, Siemens-Schuckertwerke Aktiengesellschaft, Berlin-Siemensstadt, Germany.

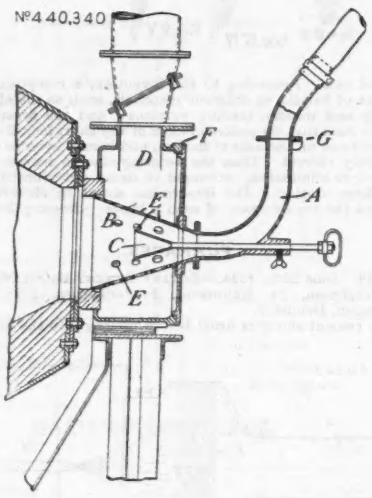
This invention relates to an improved process for the production of lead-tellurium alloys, in which additions have to be made to the base metal, the fusing temperature of which additions is considerably in excess of the casting temperature of the prepared alloy. According to the invention, the amount of tellurium necessary for any particular desired weight of alloy (preferably in the form of the lead-tellurium eutectic mixture, of which the lead content amounts to 21·5 per cent.) is added and dissolved or fused at the necessary temperature in a quantity of pure lead, which is fused and superheated to the necessary dissolving temperature and of less weight than the quantity necessary for the production of the prepared alloy and only then is the remaining quantity of lead added in solid form to the fused

mass and dissolved. No further heat is intentionally applied to the mass, but, on the contrary, the melting furnaces are built as far as possible in such a manner that even an unintentional further supply of heat is prevented, so that the fused mass can rapidly cool down to the casting temperature as the final addition of solid lead melts or dissolves. The weight of the quantity of lead necessary for fusing with the tellurium addition and also the quantity for the subsequent addition in solid form can be calculated from the fusing heat and specific heat, and the temperatures necessary respectively for fusing and for casting. It is advisable to make the quantity of pure lead subsequently added about one-half of the total quantity thereof, since then the casting temperature of the prepared alloy of about 350 deg. Cent. is automatically reached when the subsequent lead addition has melted. The process, according to the invention, avoids the combustion of tellurium, which occurs at the temperature of 500 deg. Cent.—*January 3rd*, 1936.

LIGHTING AND HEATING.

440,340. June 20th, 1934.—POWDERED FUEL BURNERS, British "Rema" Manufacturing Company, Ltd., High-road Well, Halifax, and P. Howden.

With this burner, it is claimed, an exceptionally hot and short flame is obtained, while it can be regulated to suit the working

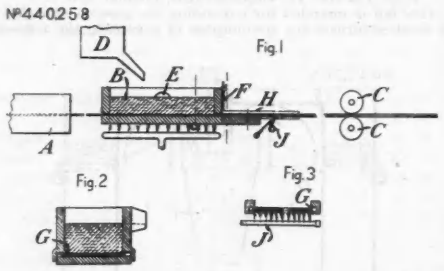


conditions. The fuel and primary air are supplied by the pipe A to the conical mixing chamber B, and are spread by the cone C. The secondary air is admitted to the chamber D, and passes through the openings E E to the mixing chamber. The mixing chamber is fixed to the cover plate, so that by breaking the joints F and G it can easily be removed.—*December 20th*, 1935.

MISCELLANEOUS.

440,258. April 23rd, 1934.—THE PRODUCTION OF BIMETALLIC STRIP, *C. Arnold*, 11, *Southampton-buildings, London, W.C.2.*

This apparatus is intended for coating one side of a steel strip with Babbitt metal. The strip is first heated in a furnace and is drawn through the bath of molten Babbitt metal B by the rolls C C. The depth of the metal in the bath is kept constant by a supply from the melting pot D and the overflow E. The



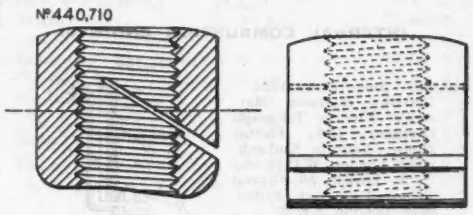
height of the outlet through which the strip emerges, and consequently the thickness of the covering, can be regulated by the adjustable gate F. The sides of the bath have narrow lips G, see Fig. 2, which fit the strip snugly and hold it down on the bottom, while they prevent the molten metal from leaking round and coating the underside of the strip. These lips are extended beyond the gate, see H, Fig. 1. The compound strip is cooled by jets of water J.—*December 23rd*, 1935.

440,641. May 3rd, 1934.—A METHOD OF FORMING PROTECTIVE LAYERS ON IRON AND STEEL ARTICLES, Dr. E. Hertel, Zülpicherstrasse 8, Bonn, Germany; and G. Becker, Gesundheitsstrasse 6, Remscheid, Germany.

This invention relates to a process for introducing chromium into the surface of articles of steel or iron by interchange with iron atoms in order thereby to provide the iron article with a layer which protects it against rust and attack by acid. According to this invention the introduction of the chromium into the surface of iron or steel articles by interchange with iron atoms is brought about by placing the article in a reaction chamber together with solid chromium chloride and raising the temperature of the chamber to 850–950 deg. Cent. (*i.e.*, about the temperature of case hardening), the chamber having an outlet through which the gaseous iron compounds which form can stream away. Reaction temperatures of 900–920 deg. Cent. are best. In carrying out the process the solid chromium chloride vaporises and reaction occurs between the vapour of the chloride and the surface of the article, with formation of iron chloride, which streams away, and liberation of chromium metal, the chromium and iron atoms thus interchanging. Instead of having solid chromium chloride present in the reaction chamber, however, vapours of this substance may be conducted to the chamber, and this constitutes an alternative form of the process. It is also possible synthetically to prepare the chromium chloride as a step in the process. In this case chlorine or hydrogen chloride is led into the reaction chamber and is first passed over heated chromium or ferrochrome before reaching the article. The gaseous chromium chloride which forms is then allowed to act upon the article at 850–950 deg. Cent. If desired, however, the synthesis of the chromium chloride may be effected in a separate preliminary chamber and the gaseous substance conducted to the reaction chamber containing the article. One advantage of the process according to the invention consists in this, that, apart from the fact that the temperature can be kept comparatively low, the process proceeds in a substantially closed reaction chamber; this, however, does not require to be subjected to a vacuum; it also does not require to be filled with inert gases, but the conversion of the gaseous compounds by which the protective layer is formed proceeds directly in the reaction chamber so that one has only to ensure a supply of gaseous chromium chloride, on the one hand, and a withdrawal of the gaseous iron compounds formed, on the other hand. The surface layers may contain up to 40 per cent. of chromium.—*January 3rd*, 1936.

440,710. June 15th, 1935.—LOCK NUTS, *A. H. Stevens*, 5–9, *Quality-court, Chancery-lane, London, W.C.2.*

This is a very extensive specification, but may be summarised in the following claim:—(1) A spring lock nut comprising a body



portion having a central threaded bore, said nut having a slot formed therein disposed at an angle with relation to the longitudinal axis of the bore, and one or more steps or ledges formed in said slot.—*January 3rd*, 1936.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

CHEMICAL ENGINEERING GROUP.—At the Rooms of the Chemical Soc., Burlington House, Piccadilly, W.1. "Some Aspects of Chemical Works Pumping and Acid Handling," Mr. E. A. Reavell. 8 p.m.

INST. OF ELECTRICAL ENGINEERS.—At Grosvenor House, W.1. Annual ball.

INST. OF FUEL.—At British Industries House, Marble Arch, W.1. Informal meeting. "The Economic and National Aspects of the Production of Oil from Coal." Professor W. A. Bone, F.R.S., will open discussion. 6.30 for 7 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Informal meeting. "The Mechanics of Gliding," Mr. Robert Kronfeld. 7 p.m,

INST. OF METALS: SHEFFIELD LOCAL SECTION.—At the University, St. George's-square, Sheffield. "Rose Engine-Turning and Enamelling," Mr. R. S. Hill. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1 "Mechanical Farming," Mr. D. R. Bomford. 7.30 p.m.

KEIGHLEY ASSOC. OF ENGINEERS.—At Cantoen of Messrs. Prince-Smith and Stells, Bradford-road, Keighley. "Engineering Development in the U.S.S.R.," Mr. Allan Monkhouse. 7.30 p.m.

MANCHESTER ASSOC. OF ENGINEERS.—Engineers' Club, Albert-square, Manchester. A general discussion on "Inspection." 7.15 p.m.

SATURDAY, FEB. 15TH.

INST. OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Engineers' Club, Albert-square, Manchester. "Alloy Cast Irons," Mr. P. A. Russell. 4 p.m.

INST. OF CIVIL ENGINEERS.—Students' afternoon visit to Beckton gasworks.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Visit to Kirkstall Power Station, Kirkstall-road, Leeds. 2.45 p.m.

MANCHESTER ASSOC. OF ENGINEERS.—Engineers' Club, Albert-square, Manchester. "Alloy Cast Irons," Mr. P. A. Russell. 4 p.m.

MONDAY, FEB. 17TH.

BRADFORD ENGINEERING SOC.—Bradford Technical College. "Hand and Machine Cutting by Oxy-fuel Flame," Mr. C. G. Bainbridge. 7.30 p.m.

ENGINEERS' GERMAN CIRCLE.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Electric Welding Machines," Herr Dr.-Ing. W. Fahrenbach. 5.15 for 6 p.m. Eliot's Club, 28, Charing Cross-road, W.C.2. Supper.

INST. OF STRUCTURAL ENGINEERS: MIDLAND COUNTIES BRANCH.—James Watt Memorial Inst., Birmingham. "The Influence of Direct Labour on Design and Construction of Small Highway Bridges," Mr. C. O. L. Gibbons. 6.30 p.m.

ROYAL AERONAUTICAL SOC.—At Inst. of Electrical Engineers, Savoy-place, W.C.2. "The Boundary Layer and Recent Development," Prof. L. Bairstow, F.R.S. 6 for 6.30 p.m.

MONDAY TO FRIDAY, FEB. 17TH TO 28TH.

BRITISH INDUSTRIES FAIR.—Castle Bromwich, Birmingham, daily. London, daily.

TUESDAY, FEB. 18TH.

INST. OF AUTOMOBILE ENGINEERS.—At Cavendish Café, Cornmarket, Derby. "Torsional Vibration in Automobile Engine Crankshafts," Dr. W. Ker Wilson. 7.30 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. "A General Comparison of Gas and Electricity for Heat Production," Mr. A. H. Barker. 6 p.m.

INST. OF ELECTRICAL ENGINEERS.—Hotel Metropole, Leeds. "Applications of the Hot Cathode Grid-controlled Rectifier or Thyratron," Mr. A. L. Whiteley. 7 p.m.

MANCHESTER ASSOC. OF ENGINEERS.—Constitutional Club, St. Ann-street, Manchester. "Simplified Methods of Combustion Control," Mr. A. Kay. 7 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. "Pig Iron and its Influence on Properties of Castings," Mr. R. C. Tucker. 7.30 p.m.

WOLVERHAMPTON AND DISTRICT ENGINEERING SOC.—At Wolverhampton Technical College, St. Peter's-square, Wolverhampton. Lecture on s.s. "Normandie," Monsieur A. P. de Malglaive. 7.30 p.m.

WEDNESDAY, FEB. 19TH.

CHARTERED SURVEYORS' INST.—12, Great George-street, S.W.1. "Engineering Services and the One-pipe System of Drainage from the Quantity Surveyors' Point of View," Mr. J. Sturton Jones. 8 p.m.

INST. OF AUTOMOBILE ENGINEERS.—Hotel Metropole, Leeds. "Needle Roller Bearings," Mr. C. H. Smith. 7.15 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Informal meeting. Discussion, "Various Advantages of Dock Gates, Caissons, and Falling Doors for Lock Entrances and Dry Docks," introduced by Mr. E. J. Buckton. 6 p.m.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND CENTRE.—Central Technical College, Suffolk-street, Birmingham. Faraday Lecture. "Television: An Outline," Dr. E. Mallett. 6.30 for 7 p.m.

INST. OF STRUCTURAL ENGINEERS: SCOTTISH BRANCH.—129, Bath-street, Glasgow. "Economical Cinema Design," Mr. J. Fairweather. 7.15 p.m.

NEWCOMEN SOC.—In Hall of Chartered Inst. of Patent Agents Staple Inn Buildings, London, W.C.1. Discussion, "The Preparation of Wood in England," Mr. H. O. Clark and Mr. Rex Wailes. 5.30 p.m.

THURSDAY, FEB. 20TH.

INST. OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOC.—St. Edmund's Restaurant, Edmund-street, Birmingham. Supper, 6.45 p.m., followed by discussion, "Alterations to Existing Means of Internal Communication to Suit Modern Methods of Transport."

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C.2. "The Development of the Single Break Oil Circuit Breaker for Metal-clad Switchgear," Messrs. D. R. Davies and C. H. Flurscheim. 6 p.m.

INST. OF FUEL: EAST MIDLANDS SECTION.—Joint meeting with Inst. of Mechanical Engineers. University College, Nottingham. "High-speed Diesel Engines," Major Goddard. 7 p.m.

INST. OF MARINE ENGINEERS.—85–88, The Minories, E.C.3. Junior Section. Film display. 7 p.m.

INST. OF PRODUCTION ENGINEERS: GLASGOW SECTION.—At 39, Elmbank-crescent, Glasgow. "Engineering Conditions in Russia," Mr. A. Monkhouse.

INST. OF STRUCTURAL ENGINEERS: YORKSHIRE BRANCH.—Hotel Metropole, Leeds. "Reinforced Concrete Structures for Retention of Water and other Fluids," Mr. W. Hunter Rose. 7.30 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—Cleveland Scientific and Technical Institution, Corporation-road, Middlesbrough. "Modern Marine Sanitary Equipment," Mr. G. Grant. 7.15 p.m.

RAILWAY CLUB.—At Royal Scottish Corporation Hall, Fetter-lane, E.C.4. Annual general meeting. Presidential address, "British Railways in 1845," Mr. Kenneth Brown. 7.30 p.m.

FRIDAY, FEB. 21ST.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND: STUDENTS' SECTION.—39, Elmbank-crescent, Glasgow, C.2. "Works Maintenance and Production," Mr. D. Carmichael. 8 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Annual general meeting. Dr. H. J. Gough will present First Report of the Pipe Flanges Research Committee. 5.30 p.m.

INST. OF METALS: BIRMINGHAM LOCAL SECTION.—James Watt Memorial Inst., Birmingham. Discussion, "Fabrication of Metal Structures." 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Hon. Members' Lecture. "Wire Ropes," Dr. W. A. Scoble. 7.30 p.m.

ROYAL INSTITUTION.—21, Albemarle-street, W.1. "Light and Temperature and the Reproduction of Plants," Prof. V. H. Blackman. 9 p.m.

MONDAY, FEB. 24TH.

INST. OF MECHANICAL ENGINEERS: GRADUATES' SECTION.—Storey's-gate, St. James's Park, S.W.1. "Locomotive Valve Practice," Mr. R. Purdie. 6.45 p.m.

TUESDAY, FEB. 25TH.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. "St. Germans Sluice and Pumping Station," Mr. R. G. Clark; and "Effect of Flood Relief Works on Flood Levels below such Works," Mr. E. C. Hillman. 6 p.m.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—At North British Station Hotel, Edinburgh. "Modern Developments in Railway Signalling," Major L. H. Peter. 7 p.m.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Joint meeting with West of Scotland Iron and Steel Inst. 39, Elmbank-crescent, Glasgow, C.2. "The Corrosion Problem in Steel," Dr. A. McCance. 7.30 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. "The Chemistry of Niobium and Tantalum and their Determinations in Ferrous Metals," Mr. T. G. Chadwick. 7.30 p.m.

WEDNESDAY, FEB. 26TH.

INST. OF ELECTRICAL ENGINEERS: N.-EASTERN STUDENTS.—Evening visit to works of Consett Iron Company.

THURSDAY, FEB. 27TH.

INST. OF CIVIL ENGINEERS.—Hôtel Metropole, Leeds. Vernon Harcourt Lecture, "Tidal and River Models," Prof. A. H. Gibson. 7.30 p.m.

INST. OF STRUCTURAL ENGINEERS.—Joint meeting with British Section of Soc. des Ingenieurs Civils de France. 10, Upper Belgrave-street, S.W.1. "The Strengthening of Weak Bridges," Mr. C. S. Chettoe. 6.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE ANDERSON-GRICE COMPANY, Ltd., has opened an office in London at Windsor House, 46, Victoria-street, S.W.1—telephone number, Victoria 3989—at which address its London representatives—Mr. Kennish and Mr. Richards—may be communicated with.

THE HEENAN CONSTRUCTION COMPANY, Ltd., structural engineers, Newton Heath Ironworks, Manchester, has acquired the assets of the Newton Heath branch of Heenan and Froude, Ltd., Worcester, as from September 1st, 1935. The *personnel* and organisation remain the same.

PROBLEM OF METALLIC WEAR.—The Institute of Metals is arranging a special meeting to discuss the subject of "Metallic Wear." It will take place in London on March 10th in connection with the Institute's annual general meeting. The discussion will be opened by Dr. H. W. Brownsdon (Member of Council), with a paper which reviews some of the major factors involved in metallic wear, and indicates a method by which they can be quantitatively assessed. The problems involved interest not only engineers, but also chemists, physicists, and metallurgists. The special aspects of the subject appealing to those workers will be dealt with by contributors to the discussion. As the subject is one of wide interest, members of other institutions, including the Institution of Mechanical Engineers, the Institution of Naval Architects, the Institution of Automobile Engineers, the Iron and Steel Institute, and the Royal Aeronautical Society, have been invited to attend the meeting and to take part in the discussion. Cards of invitation may be obtained from Mr. G. Shaw Scott, M.Sc., Secretary, the Institute of Metals, 36, Victoria-street, London, S.W.1.

A Seven-Day Journal

Rationalisation.

DELIVERING the Rankin Lecture in Liverpool on Monday last, Mr. Frank Hodges, of the Central Electricity Board, said that in his judgment the social problem was the most pressing problem of Reorganisation. He considered that there should be a new form of Ministry, under a special Minister of the Crown, whose task would be not, so to speak, to impede technical development, nor merely to solve the problems created by too swift technical development, but so to watch and direct, and influence technical and commercial movements that the transitional phases of the social problem might be mitigated in the case of those individuals who were the direct sufferers from the problem. Movements in industry, involving displacement, should be the subject of licence by the Minister, notification of the scrapping of industries or works should be compulsory, the effect of the introduction of labour-saving machines should be reported. If a whole industry were involved, the question of reductions in hours for such an industry should be investigated and consultations between the Minister and the industrialists should be initiated in order to discover whether a shorter working day would neutralise the benefit of the labour-saving plant. If it could be shown that there was still a saving in consequence of the labour-saving plant even after a reduction in the working day, then such reduction should be introduced and the social problem thus mitigated. By these means, the planning of our industrial future and the solution of our industrial problems consequent thereon could be attempted under intelligent central control, such control possessing the requisite statutory authority. To provide ways and means in periods of depression, there would have to be, naturally, extraordinary measures taken to mitigate the temporary problems of the depression, but with these he was not concerned at the moment. He was solely concerned with those problems that followed in the wake of technical evolution, which, from every point of view, should never be arrested. It was only when the gain to the community as a whole was in doubt that there should be a temporary halt until it was discovered whether the community would suffer a hurt or not.

Motor and Trollybus Progress.

THE Ministry of Transport returns for tramway and trolly vehicle undertakings in Great Britain, excluding those transferred to the London Passenger Transport Board, which have just been issued, show the progress now being made by motor and trollybus vehicles, which are gradually but surely superseding tramway vehicles. According to the returns, during 1934–35 there were 2,651,557,025 passenger journeys made on trams, compared with 2,774,979,452 in 1933–34, a decrease of 123,422,427, or 4·45 per cent. The car miles travelled totalled 228,406,797, compared with 239,450,290 in the previous year, a decrease of 11,043,493. The tramway route mileage at the end of the period covered by the returns was 143 miles less than at the end of the preceding period. This decrease is to be largely attributed to the abandonment of tramways in favour of trolly vehicles or motor omnibuses. The number of passenger journeys made on trolly omnibuses was 309,489,352, compared with 227,083,825 in 1933–34, an increase of 36·29 per cent. The capital expenditure of the undertakings in 1934–35 was £58,141,567, a reduction of £2,775,643 on the previous year, a reduction mainly caused by the writing off of the cost of superseded tramway capital assets. The gross receipts were £14,721,510 and the working expenditure £11,562,357, making the net receipts £3,159,153, or £292,966 more than the net receipts for 1933-34.

The Late Sir William Forbes.

LIEUT.-COLONEL SIR WILLIAM FORBES, who died at the age of seventy-nine at his home in Maida Vale on Friday last, February 14th, played a leading part in railway development in the South of England, and was the general manager of the London, Brighton and South Coast Railway Company until it amalgamated with the South-Western and the South-Eastern and Chatham, in order to form the Southern Railway Company. He was born in Dublin in 1856, when his father was then general manager of the Midland Great Western Railway of Ireland. He was educated at King's College, Dulwich College, and on the Continent, and began his railway career under his uncle, Mr. James Staats Forbes, who was then the general manager of the London, Chatham and Dover Railway. After serving in several capacities, William Forbes was appointed continental manager in 1889 and traffic manager shortly afterwards. In 1898 he became assistant general manager of the amalgamated South-Eastern and Chatham Railway. In 1899 he was appointed general manager of the London, Brighton and South Coast Railway. Among the improvements he introduced were the deviation line from South Croydon to Earlswood, the reconstruction of Victoria Station, the introduction of Pullman trains to Brighton, and improved through trains on other routes, faster and better Channel boats, and boat train services. During the war, as a member of the Engineer and Railway Staff Corps, Lieut.-Colonel Forbes was called upon to carry great responsibilities, which meant the reorganisation of both passenger and goods services. The work he did for the War Office and the Admiralty was recognised by the knighthood conferred upon him in 1915. He also received the Legion of Honour, the Belgian Order of Leopold, and the Danish Order of Dannebrog. His name will long be associated with the Southern Railway and the scheme for its electrification, which was begun during his time, and has since proved so profitable to the company.

The Naval Conference.

FURTHER meetings of the Drafting Sub-Committee of the Naval Conference took place during the period under review, and progress was made in the work of drafting the clauses of the Treaty dealing with the size limits of ships in the classes of cruisers, aircraft carriers, and submarines now being considered. The limits for capital ships formed the subject of further informal conversations between the various delegations, and the heads of the French and Italian delegations left for Paris and Rome in order to discuss again, it is believed, the subjects upon which agreement has still to be reached. These include, it is understood, the qualitative limitations of capital ships and the procedure which is to be adopted for inviting the accession of Naval Powers not taking part in the Conference to any agreement which may be drawn up, and the precise form of the treaty which might embody such an agreement. Meetings of the Drafting Sub-Committee took place on Wednesday morning, and further meetings of the more important Committees of the Conference will take place, it is expected, when the heads of the delegations now away return to London.

Agricultural Engineering.

THE Council of the Society of Engineers announces that it has decided to form an Agricultural Engineering Section to which only qualified agricultural engineers will be admitted, along with highly qualified members of the teaching staffs of agricultural colleges and those holding official agricultural positions in the counties. In this way the Council feels that the status of the agricultural engineer will be enhanced, and an opportunity afforded of reading and discussing papers dealing with the technical side of agricultural engineering work. The readers of papers in this new section will, it is announced, be eligible to compete for the several premiums offered by the Society, including the President's Gold Medal, which are annually awarded by the Council. It may be recalled that over 200 persons recently attended a conference on Mechanisation in Mixed Farming, which was held at Oxford, when Mr. S. G. Wright, Deputy Director of the Institute for Research in Agricultural Engineering, gave three lectures on the Engineer's Contribution to Agricultural Evolution. The founding of this new section of the Society of Engineers has been supported by many interested societies, and the Secretary, Mr. A. S. E. Ackermann, invites applications from engineers and others who may be eligible for membership.

The Tramp Shipping Subsidy.

IN view of the proposal of the Government to continue the Tramp Shipping Subsidy, and the recognition of all parties and sections of the community of the need for maintaining the British mercantile marine, the Shipowners' Parliamentary Committee has prepared a case for the support of the proposed Government Bill, which it has sent to every Member of Parliament. The particulars furnished by the industry reply forcibly to the attacks which have been made on British shipping industry, and go to show that the industry has furnished an example of what can be done by close co-operation, all sections of the industry having acted through the Merchant Shipping Advisory Committee and the National Maritime Board. In supporting the need for a continuance of the subsidy, the statement also deals with the restoration of world trade, on which the complete revival of the industry must ultimately depend. Mention is made of the services rendered in the past and effective answers are given to the suggestion that the industry has either made excessive profits in the past or has since wasted its substance.

L'Atlantique.

ON Wednesday, February 12th, it was officially announced in Paris that the burnt-out hull of the French liner "L'Atlantique" had been purchased from the French Ministry of Marine by Messrs. Douglas and Ramsey, of Glasgow, for £57,000. It is to be removed from the dock at Le Havre, where it is now lying, within a stipulated period, and it is probable that Dutch tugs will be chartered to bring it to the Clyde where it will be broken up at the yard of Smith and Co., of Fyfe Park, Port Glasgow. Interest attaches to the turbine propelling machinery, which is modern in design and, if not unduly damaged by fire and rust, should be available for installation in another vessel. Last week the Marine Commission of the French Senate decided that a new ship should be built to replace "L'Atlantique." It is understood that a tonnage of about 30,000 is to be considered, with a speed of at least 25 knots, which, it is held, would enable the new liner to compete successfully on the South American route. The successor of "L'Atlantique" will, like that ship, be built at the Penhöet yard at St. Nazaire, and, according to latest news, will, it is anticipated, be a vessel of 744ft. in length. The design of her hull, it is further stated, will be based on that of the "Mauretania."

The B.E. and A.I. Research Association.

DURING the course of his address at the annual luncheon of the British Electrical and Allied Industries Research Association, held at the Savoy Hotel on Friday, February 14th, Sir William J. Larke remarked that research was one of those services far too frequently treated by those asked to bear the cost as a gift from the gods. They claimed that it called for expenditure for which they had no guarantee of repayment. But if they could have such a guarantee it would not be "research." Under the new grant policy of the Department of Scientific and Industrial Research, the resources of the Association had increased during the past year by £15,000. The conditions of the grant to the Association were, however, such that it was possible for it to obtain a further grant of £8000 per annum, provided those at present responsible for the industrial contributions increased their contributions by a like amount. Under present conditions there was no other investment which industry could make that would yield such a handsome immediate return in cash, and it would be a reflection on the business acumen and enterprise of the industry if the Association were not enabled to qualify for this additional contribution. The turnover of the electrical manufacturing and supply industries was £180,000,000 per annum, and on that basis the total expenditure of the Association represented 0·08d. per pound of gross revenue, or 0·036 of 1 per cent. of the turnover. Collective research as carried out by the Association was not only an investment which had already yielded a return greater than that of any other sphere of activity, but an insurance of progressive prosperity at a negligible premium.

Waterloo Bridge.

A FURTHER stage in the demolition of Waterloo Bridge was successfully completed by Sir William Arrol and Co., Ltd., during the early hours of Sunday morning, February 16th, when the steel staging which had supported the arch of the bridge crossing the embankment during its demolition was removed and loaded into barges. The traffic on the Embankment was stopped at midnight on Saturday, and shortly afterwards, with the aid of two 6-ton petrol-electric mobile cranes, the six 10-ton girders which had formed the underpinning structure for the demolished span were lowered and dismantled. They were then lifted by a 6-ton crane, operating from one of the piers, into barges waiting in the river. The removal of the whole of the steelwork was effected in less than seven hours, and by 8 a.m. the Embankment was again open to traffic. The work was carried through so expeditiously that it was unnecessary to close the Embankment to traffic until midday on Sunday, as was originally arranged by the Commissioner of Police. The dismantling of the remaining bridge piers is proceeding according to plan, and the foundations of Nos. 5 and 6 piers are now being removed, while cofferdams of steel piling are being driven in order to allow similar work to proceed on other piers.

The Metadyne Train Control System.

PARTICULARS have just been issued by London Transport of the Metadyne control system that is being applied to the new rolling stock to replace that in operation on the Hammersmith and City line and for the extension of that service to Barking. It is the invention of an Italian engineer, G. M. Pestarini, and has been developed by the Metropolitan-Vickers Electrical Company. Rates of acceleration and deceleration much in excess of those obtained with the normal equipment are possible, and a saving in current consumption is secured. The current passes to the negative rail through the metadyne, which is a rotary transformer driven by a regulator motor. Current in the primary circuit of the transformer induces current in the secondary circuit, which feeds the traction motors through brushes. Acceleration is obtained entirely without jerks, and on the new stock an acceleration of 2 m.p.h. per second is aimed at. A speed of 20 m.p.h. will thus be obtained in 10 sec. without discomfort to the passengers. There are three braking systems—the regenerative brake for normal service requirements used in conjunction with the standard electro-pneumatic brake, and a Westinghouse brake for emergency use. Combined regenerative and electro-pneumatic braking will be used to produce a service braking of .3 m.p.h. per second. It is estimated that if regeneration could be used exclusively for braking, a saving in energy of approximately 30 per cent. would be obtained with the metadyne equipment. As it is not advisable with this control system to take lighting current direct from the rails, each train unit has a generator which charges a 50-volt lighting battery.

American Beach and Shore Protection Works.

By E. E. R. TRATMAN.

No. VI.

(*Concluded from page 170, February 14th.*)

The Florida Coast.

THE east coast of the State of Florida is mainly a long stretch of wide sand beaches, broken at long intervals by streams. Along this coast are a number of popular winter residence towns and resorts. Like the Gulf Coast, it is subject to hurricanes, with a wind velocity of 40 miles an hour; these come from the south-east and occur at average intervals of twelve or fifteen years. But each year there are likely to be several north-east storms, with wind velocities almost equal to the hurricanes. During the prevailing south-east winds the beach builds up on the south side of groins, although the littoral drift of the sand is southward. But as the heavier seas are from the north-east storms, they accentuate the littoral drift, so that the net result is more building up on the north side of the groins and more erosion on the south side.

Some protection against the wave forces of moderate storms is provided by the flat slope of the sea bed beyond the beach, and by off-shore sand bars. In past years enormous damage has been done in the way of beach erosion, and also in the washing away of valuable water-front property, and the more or less complete destruction of shore-line residences and other structures. Here, as on the coast of New Jersey, further north, the continual erosion, in the aggregate, far exceeds the accretion.

Groins have held the beaches in some cases, but when overtopped by waves there is usually heavy erosion on the leeward side, while erosion in rear of the groins may result from inadequate bulkhead or sea wall protection. Furthermore, with storms from opposite directions, the leeward side at one time may become the windward side at another time. On the whole, it has been considered doubtful whether groins alone would be sufficient protection, since the storm frequency was such that the fine-weather intervals would be too short for building up beaches capable of resisting wave action. One special and peculiar factor that prevents the use of groins on some parts of this coast is that a section of the wealthy and sporting element of the transient population demands the use of the smooth, firm beach for automobile riding and racing.

According to a description published in the *Engineering News-Record* after a great hurricane in 1926, the situation as to beach erosion on the Florida coast was as follows:—

"When a coast like the Florida East Coast is swept periodically by storms of hurricane characteristics, with shifting seas, currents and bars, and storm tides of extraordinary height, groins must be eliminated as a first line of defence in favour of an adequate sea wall barrier, with or without the aid of groins or offshore breakwaters.

"The movement of the Gulf Stream northward a few miles from the coast of Florida causes a return current southward alongshore. This current is of considerable velocity and of some importance as a sand carrier with storms from the north-east. A north-east storm erodes the beaches and good weather builds them up. This is caused by the storm acting with the littoral drift moving in its own direction. The under-tow transporting the sand follows the coast southward and breaks out at frequent intervals into deeper water, probably forming new bars. The waves of translation striking the coast from south-of-east, and bearing the sand from the bars probably formed by the north-east storms, normally create an undertow toward the north. This undertow, meeting the littoral drift moving in a southerly direction, loses some of its velocity and deposits the sand. As the prevailing wind is from a little south-of-east, good weather may be depended upon to build up the beaches, with or without artificial aid."

Since the above report was written there has been a large amount of protective work done, owing to the great increase in the development of Florida as a winter resort. With reference to the use of breakwaters, there appears to be no case where such works have been built for the sole purpose of beach protection. Such a breakwater was proposed to protect a beach on Lake Michigan, as will be noted later; but the plan was abandoned as far too expensive; a series of groins was built instead.

Much of the trouble on the Florida coast, as elsewhere, has been due to lack of co-operation between owners of ocean-front property and a consequent line of defence that has numerous gaps and includes a variety of protective works whose design is in many cases based on cheapness. Works built by individual owners were often open to flank attack from adjacent unprotected property. Groins were very generally about 100ft. long and 100ft. apart, built of 4in. planks driven vertically between waling pieces 6in. by 8in., and reinforced by 16ft. timber piles about 8ft. apart. At Palm Beach, where the beach is steep and narrow, and the sand is not well compacted, groins built in 1926 caused sand to build up on the north side, but the swift ebb tides carried the sand so far out that it was not deposited along the south side.

While bulkheads or sea walls of concrete sheet piling and precast slabs have been built in several places on this coast, they are generally 75ft. to 100ft. inshore of the high-water line, so that they are only touched by salt water when storms occur at high tides. Another type of structure used under similar conditions consists of steel piles—old railway rails or rolled sections—spaced about 6ft. apart, with precast slabs vertically between them. The slabs have enlarged ends socketed or recessed to receive the piles, the joints and the open space around the steel being then filled with concrete or grout.

Much of the property along this coast—as elsewhere—is not of sufficient value to warrant the cost of more massive or substantial protection built nearer the water line in order to hold or reclaim the land. Besides this, it is considered that owing to the littoral drift of the sand it would soon be necessary to supplement such heavy sea walls with groins in order to keep the sand along the foot of the wall.

Miami Beach Protection.

Following a very severe hurricane in the autumn of 1926 special studies were made for the protection of the City of Miami Beach, where the shore line was continually shifting with changes in wind and weather. The result was the adoption of interlocking steel sheet piling for a series of groins and also for the bulkhead or sea wall. These groins are 100ft. to 300ft. apart, with a length of about two-thirds of the spacing, or 200ft. long for the 300ft. spacing. These works have secured a satisfactory beach between the groynes, and in 1929 they successfully withstood the attacks of a storm which attained a wind velocity of 70 miles an hour.

For the groins, Fig. 43, trough-shaped steel interlocking piles, 18ft. long, are secured to two lines of waling pieces of 6in. by 10in. creosoted timber. Against these wales are driven 25ft. creosoted piles, about 4ft. apart. Similar but somewhat cheaper construction at private property consisted in using untreated piles wrapped with wire mesh and coated with 1½in. of cement grout—or "gunite"—applied by a compressed air "gun." The tops of the groins are about 2ft. above low water at the outer or sea-ward end, and 6ft. above at the landward end.

For the sea wall—Fig. 45—the steel sheet piles are 23ft. long, except that every sixth pile has a length of 36ft. Their tops are about 8ft. above mean low water. On the land side, and 4ft. from the top, is a 10in. rolled steel channel as a waling piece. This channel bears against the backs of alternate piles, and is bolted to the other or concave piles, a wood block or filler being placed between the channel and the pile.

At 10ft. in rear of this sheeting is a row of creosoted anchor piles, 25ft. long and 8ft. apart, having their tops at 6in. above low water level. On the land side of these piles is a timber waling piece 10in. square. From the head of each pile an inclined timber strut or brace extends to the underside of the steel wale on the sheeting, to which it is bolted. Two 1in. steel rods, on opposite sides of the strut, are bolted through the timber waling piece and the faces of the concave sheet piles.

The coated or "gunited" wood piles are reported in good condition. Only the lower part was thus treated before driving, the coating of the upper part being applied later. Timber and steel bulkheads or sea walls thus "gunited" after construction have given good results, but as they are at some distance back from the water, they have not had to resist the battering of waves to any extent. They are also well protected by the sand, as the beach has built up nearly to the tops of the walls. A recent inspection of the steel sheeting in the sea wall showed that there has been little or no corrosion below the sand line. With creosoted piling it has been found that the teredo—which attacks timber between the sea bed and high water line—has entered at bolt holes and other places where the timber was cut in the field. This demonstrates the value of modern practice in

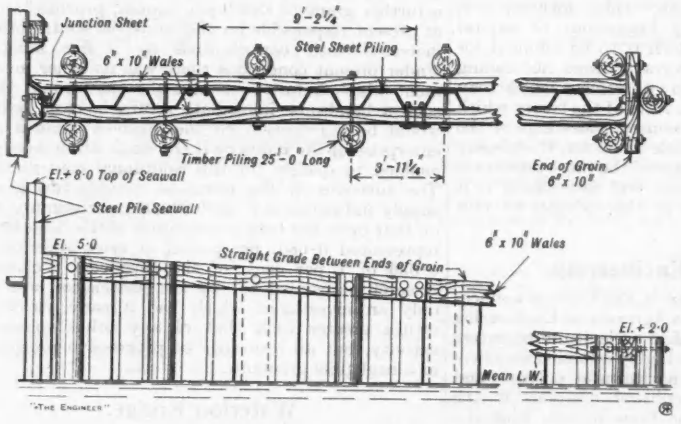


FIG. 43—GROINS AT MIAMI BEACH

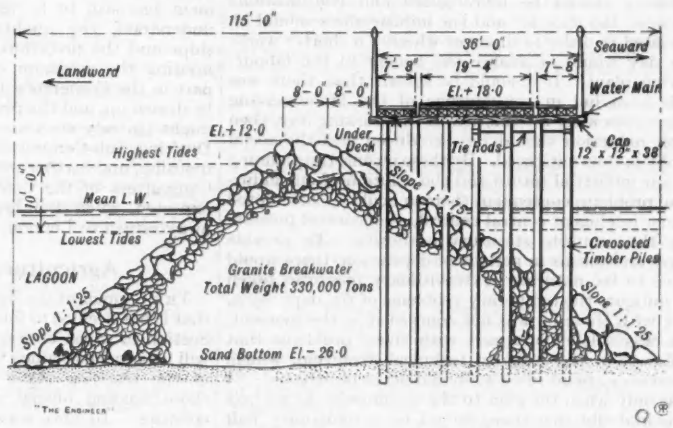


FIG. 44—BREAKWATER AT LONG BEACH

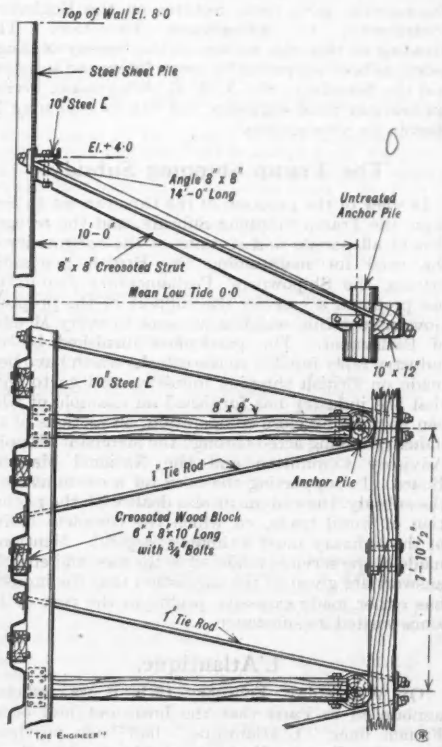


FIG. 45—SEA WALL AT MIAMI BEACH

doing all possible cutting, boring, and framing before timbers are creosoted.

MISCELLANEOUS SHORE PROTECTION WORKS.

Besides the types of beach and shore protection works in more general use, there are a number of such works of special design, intended to meet certain local conditions or to represent the particular ideas of the designers. Before noting some of these mention may be made of a successful attempt to overcome the trouble of wave crests and spray coming over the top of a sea wall at the Key West Dockyard of the United States Navy. As originally built, the wall had a face batter of 3in. to the foot and its top was level with the ground surface. To form a coping or throw-back, the top front edge of the wall was cut away vertically to a depth of about 14in., leaving an inset of 3½in. at the bottom of the cut. Anchor rods were set in drilled holes and a concrete coping was built, 9in. wide on top—or 9in. projection from the face of the old wall—and flush with the top of the wall. Its outer end was 3in. thick and then a curve ran back and down to meet the face of the old wall at the edge of the inset.

CONVEX SEA WALL.

While sea walls with concave faces to divert and throw back the waves represent a rather common design, a novel structure is a sea wall with a convex face, as used for a length of about 4 miles on the Gulf Coast. The wall is on the shore line of Jackson County, in the State of Mississippi, and is almost a continuation of the Harrison County stepped wall, 25 miles long, already described (Figs. 1 and 2 *ante*). It was considered by the designer, Mr. Franklyn H. McGowen, consulting engineer, that sea walls in general were subject to erosion in the rear and at the toe unless adequate aprons were provided at top and bottom as continuations of the wall proper.

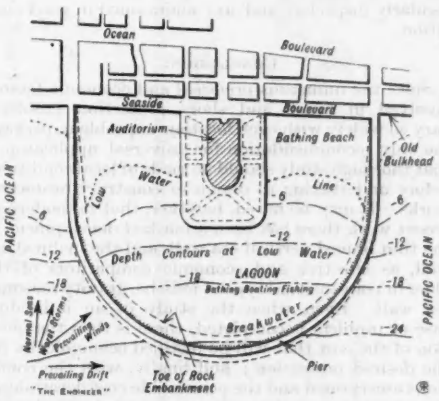


FIG. 47—SEMI-CIRCULAR BREAKWATER AT LONG BEACH

The convex design—Fig. 46—with its toe buried deep in the beach and its top extended into a broad concrete driveway, would be considered to prevent such erosion and at the same time cost less than other types of construction. The height of the wall is only 6ft. At the toe is a line of concrete interlocking sheet piling driven on an inclination of 5 vertical to 1 horizontal. The bottom of the wall forms a longitudinal beam or girder enclosing the top of this sheeting. Above this beam the wall rises on a curve of 10ft. 6in. radius, extending back to a point 9ft. in rear of the toe. This curve runs smoothly into an inclined portion 3ft. wide, which serves as a walk. The curved slab has a thickness of 7in. to 12in., and rests upon a bank of sand pumped into place. No piles are used under the rear or land end of the wall.

Along this end of the wall and built as a monolithic part of it is a wave break, 18in. high, consisting of posts 9in. high and 12in. square, spaced 5ft. on centres and supporting a continuous slab or seat 9in. thick and 12in. wide. Upon this wave break are standards for electric lights. Beyond the curved slab, but resting upon it, as shown, is a concrete surface 30ft. wide, for a driveway and parking space. In level ground this pavement ends with a low kerb, but where the roadway is cut into higher ground it has a low retaining wall at the property line, as is also shown.

SECTIONAL SEA WALLS.

While most of the large vertical gravity sea walls of concrete are of the solid or gravity type, a distinct type is the Weber system, which is a combination of precast ribs or counterforts with a concave face slab poured in place. An example of such construction is a wall built for the protection of a private estate at Palm Beach, Florida. The foundation consists of 85lb. flange rails, 33ft. long, used as piles. These were driven through the beach sand into the underlying coral rock, the surface of which is from 2ft. above to 10ft. below the low-water level.

This wall is 23ft. high, with its top 17ft. above mean low water. Its width is 15ft. 3in. at the base and 2ft. 9in. at the top/coping. Beneath the toe is a curtain or cut-off wall 8ft. deep. Precast counterforts or transverse girders have a horizontal base and vertical back, with the upper or forward side curved to the shape for the face slab. These are seated on the rail piles at intervals of 10ft. and are connected by a line of precast longitudinal concrete beams resting in notches in the curved faces. Precast slabs also form the cut-off wall. From all the precast pieces certain of the reinforcing rods project to bond with the poured concrete.

With counterforts and beams in position the forms and steel reinforcing are placed for the face slab. This is poured in sections 30ft. long and is monolithic with the bottom beam and top coping. From a short horizontal part at the bottom, 2ft. above low water, the face starts upward on a parabolic curve of gradually decreasing radius and running into an outward curve at the top, which forms a throw-back for the waves and surf.

Stairways are formed by steps cast integrally with the face slab and following its curved surface, so that there is no projection from the wall, as in other stairways previously described. Here, as at Hampton Beach, the top of the wall forms a parapet and openings are necessary at the stairways. Provision is made for closing these in case of violent storms by means of timbers or panels.

With the sectional design the construction work is simple and no cofferdam is required. The precast counterforts, 12in. thick, are spaced 10ft. apart and are seated on the piles at 4ft. below low water. The face slab was poured in 30ft. lengths, with interlocked expansion joints filled with ½in. prepared fillers. Weep holes provide for seepage from the ground. The bottom portion or apron of the curved face is made horizontal in order to reduce the scouring action of receding wave wash. While special concrete mixtures are often used in such marine work, a feature of the Weber system is the use of diatomaceous silica or infusorial earth in the concrete for the precast units, to transform the free lime of the concrete into a stable calcium silicate and at the same time make the wet mixture more dense and workable.

BEACH BREAKWATER.

An offshore breakwater has been proposed in some cases as a means of beach protection, but is expensive and rarely meets the requirements. However, a very curious and unusual protective work at the city of Long Beach, in California, consists of a semicircular breakwater of heavy loose rock, having its outer part in deep water while its ends extend across the beach to the higher ground behind it. This arrangement is shown in Fig. 47. At this place there has been frequent erosion by storms, and thin sea walls of timber and concrete on wood sheet piling, as built both by property owners and the municipality, have proved quite ineffective to check the erosion or resist the wave attacks. This new work was built in 1930. The extreme tidal range is about 10ft.

This breakwater (Fig. 44) paralleled by a timber pier around its ocean face, encloses about 1800ft. of beach and extends about 1300ft. from the shore line. It checks the continual erosion and also the strong littoral drift of the beach sand, while it forms a protected lagoon with a bathing beach free from the rough surf which prevails along this part of the coast. At the middle of the beach is a rectangular filled enclosure of made land, 500ft. wide and extending out 700ft. from the boulevard which runs along the shore line. The filling is retained by a wall or vertical bulkhead of creosoted interlocking timber sheet piling. Upon it are a municipal auditorium, 170ft. by 400ft., and a public garden. The depth of water within the breakwater is from 5ft. to 25ft.

In the breakwater, built of quarried granite blocks, the slope on the seaward side is 1 vertical on 1½ horizontal; on the inner or lagoon side it is 1 on 1½. The width is 8ft. on top and about 115ft. on the bottom. With a height of about 35ft. there is a freeboard of 2ft. above maximum high tide. In the curved seaward portion only massive blocks were used, thus leaving ample openings for the free passage of water. In the shore ends, however, which serve as groins crossing the beach, the rock mass is much more

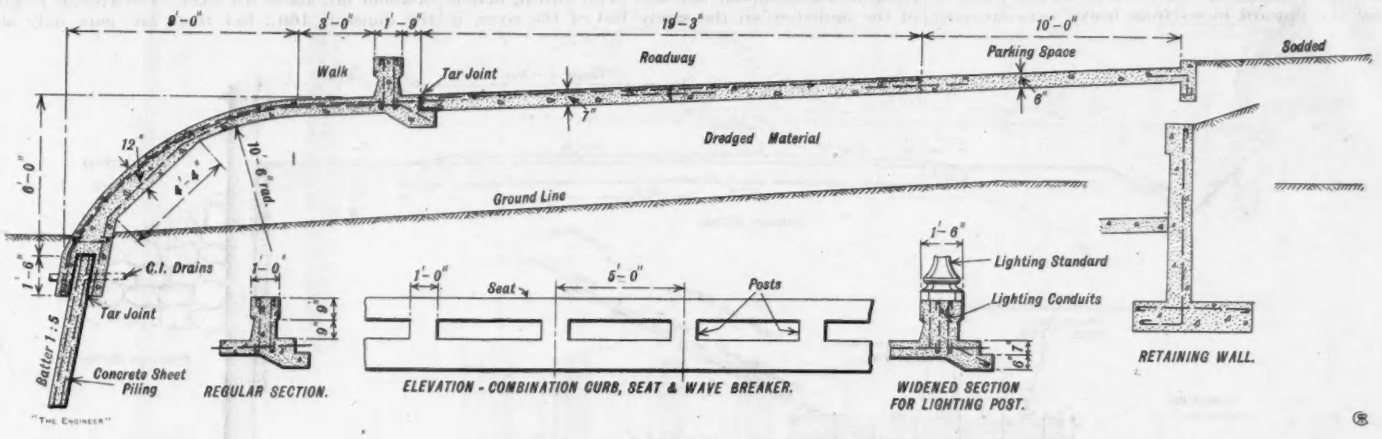


FIG. 46—CONVEX SEA WALL ON GULF COAST

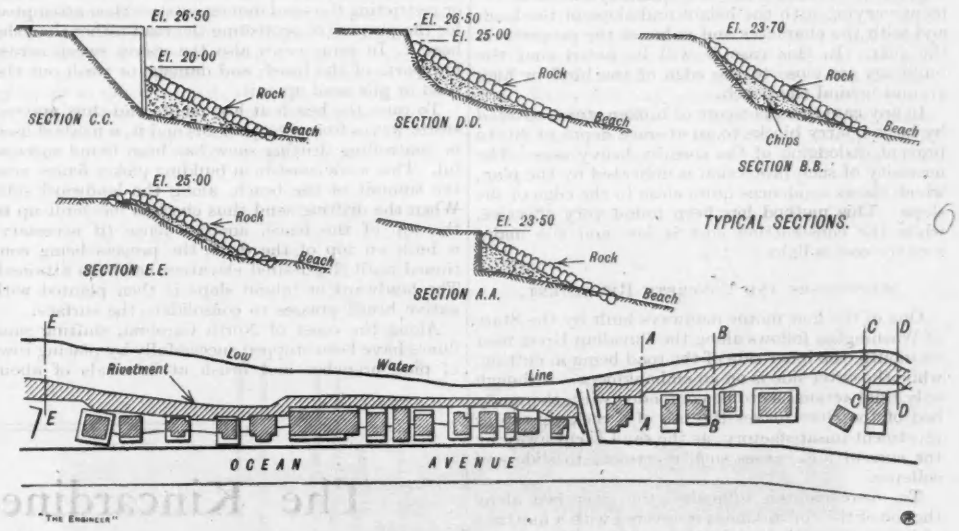


FIG. 48—ROCK REVETMENT ON MASSACHUSETTS COAST

dense. This arrangement, however, has led to some trouble, from its interference with the southward drift of sand along the shore. The beach here is of fine sand, 10ft. to 25ft. deep, with a flat surface slope of 1 on 50.

The pier built over the seaward slope of the breakwater is nearly 4000ft. long. It is of the trestle type, consisting of seven rows of creosoted piles, in transverse sets 15ft. apart, with a penetration of 20ft. or more. Transverse cap timbers, 12in. by 12in. and 38ft. long, carry joists or stringers for the 15ft. spans, the deck or floor of which is 8ft. above extreme high tide, or 6ft. above the top of the breakwater. In the centre of the deck is a roadway 20ft. wide, formed by planks 2in. by 4in. laid on edge in close contact and covered with a 5in. paving of asphaltic concrete. At each side of this roadway is a walk 8ft. wide, paved with 3in. plank.

All the planking is well secured to the joists to resist the upward blows from heavy seas sweeping under the pier. To break the force of the crests of such waves a sub-deck of 4in. by 8in. transverse timbers, spaced 10in. between centres, is fastened to the underside of the joists.

Rock Revetment.

To protect property on high ground behind the beaches from erosion by wind and weather and occasional waves at high tides, various designs of retaining walls or bulkheads have been used, as already described. At some points along the coast of Massachusetts such protection is afforded economically by a revetment of rock work along the toe of the slope and extended to the top. Much work of this kind has been done by the Department of Public Works of that State. An example at Marshfield is shown in Fig. 48, the arrangement and quantity of the revetment varying with the height and slope of the bank and with the character and value of the property in the rear. In this case it will be noted that the buildings are close to the edge of the bluff or high ground behind the beach.

In any case there is a core of broken stone, covered by large quarry blocks to an average depth of 2ft. to prevent dislodging of the core by heavy seas. The necessity of such protection is indicated by the plan, which shows residences quite close to the edge of the slope. This method has been found very effective, while the construction cost is low and the maintenance cost is light.

Mattresses and Concrete Revetment.

One of the new motor highways built by the State of Washington follows along the Puyallup River near its mouth, the inner side of the road being in cutting, while the outer side is on an embankment. Although only tidal action has to be contended with, the sandy bed of the river makes the use of a rock rip-rap or revetment unsatisfactory, as the sand is cut away by the current and causes such revetment to slide and collapse.

To overcome this difficulty, the river bed along the toe of the embankment is covered with a mattress of brush 18in. thick and 25ft. to 35ft. wide, the toe of the embankment extending 3ft. or 4ft. over the inner edge of the road embankment. This arrangement is shown in Fig. 49A. The mattress work is of fir brush, or small fir trees, 12ft. to 25ft. long, with butts of 2in. to 5in. diameter. This is wrapped at 5ft. intervals with second-hand steel wire cable and tied with heavy wire.

When in place, the mattress is loaded with sacks of concrete, weighing 100 lb. per sack. The embankment is dressed to a slope of 1 on 2 and paved with 5in. of concrete reinforced with electrically welded steel netting of 6in. by 6in. mesh. At the toe of the concrete slab, this steel fabric projects 18in. from the concrete, and is bent flat to lie on top of the mattress, to which it is secured by wires tieing it to the first wrapping of steel cable.

At its upper edge, the concrete slab is turned nearly horizontal, and is buried in the steeper slope of the shoulder of the road above. This road is 60ft. wide, with a drainage ditch along its inner side, which is in excavation. These brush mats below the low-water line have proved to be effective protection against scour and undermining of the concrete revetment.

A revetment of sacked concrete is often used in similar cases when rock foundation is available, and protection is needed mainly against tidal action, with little trouble from current or waves.

Timber Bulkhead.

Another of the new highways of the State of Washington follows along the north bank of the Columbia River, near its mouth, and, like the road previously described, has one side in cutting while the other side is on an embankment having its toe in the river bed. Owing to the waves resulting from the exposure to south-west winds blowing in directly from the Pacific Ocean, and also to the cutting action of the undertow on the sandy bed of the river, it has been found impossible to maintain rock revetment for protection of the embankment.

To meet this condition, a vertical bulkhead or wall—Fig. 49B—was built of cedar piles, alternately 25ft. and 28ft. long, spaced 4ft. on centres, and having planks 4in. by 12in. placed horizontally against them. Loose rock is deposited along the toe of this wall. The embankment is filled in level to within 3ft. of the tops of the longer piles, which form posts, to the heads of which is bolted a fender timber 6in. square.

Sand Fences Along Beaches.

In certain localities the drifting sands and shifting dunes along the shore invade shore line highways, and cause continual trouble and expense in keeping the roads clear at such places. Methods of checking or restricting the sand movements are then attempted for the purpose of protecting the road rather than the beach. In some cases also the waves sweep across low parts of the beach and damage or wash out the road or pile sand upon it.

To raise the beach at low points and thus prevent storm waves from sweeping beyond it, a method used in controlling drifting snow has been found successful. This work consists in building picket fences near the summit of the beach, along the landward side. When the drifting sand thus checked has built up to the top of the fence, another fence (if necessary) is built on top of the drift, the process being continued until the desired elevation has been attained. The landward or inland slope is then planted with native beach grasses to consolidate the surface.

Along the coast of North Carolina, shifting sand dunes have been stopped successfully by placing rows of pine branches and brush at intervals of about 100ft., beginning at the foot of the dune on the side from which most of the sand is blown, and continuing these rows up to the summit and for a little distance down the farther slope. Early in the first spring after this work, native grass seeds are sown in the brush cover. These grow and spread until the grass holds or anchors the dune and other vegetation begins to grow. Another method is to set out bunches of native grass at intervals of a few feet over the entire surface of the dune. In serious cases, large dunes have been covered with wood mould and then sowed and sodded with grass, while shrubbery was also planted.

In Delaware the State Highway Department built a road along a barrier beach—separated from the shore by marsh lands—in order to eliminate a round-about route of 40 miles between popular seaside resorts. This road was located behind the dunes, where they meet the marsh lands, and at an elevation of about 6ft. above sea level. The average height of the dunes is 16ft., but there are gaps only about 9ft. high, and in heavy storms from the east and north-east the waves poured through these gaps. To close these gaps, fences were built across them, on the front or sea side of the dunes, the ends being extended well into the slopes of the dunes in order to prevent erosion at these points by the winds. Posts 8ft. long and 8ft. apart were planked to a height of 6ft., spaces of 3in. being left between the planks. The aggregate length of these fences was nearly 4 miles. Sand began to pile up along the fences at once, and most of these fence drifts withstood heavy storms successfully in 1933. As erosion once started in the dry sand would proceed rapidly, the fences are regularly inspected and are maintained in good condition.

Conclusion.

Since the numerous practical and economic factors involved in beach and shore protection problems vary so widely with each location or problem, perhaps the only recommendation for universal applicaton is that thorough study should be made of local conditions before undertaking to design or construct protective works. It may be noted, however, that in modern or recent work there has been a marked development of the thin braced vertical sea wall, and the inclined sea wall, as effective and economic competitors of the older or conventional type of massive gravity masonry sea wall. Even when the study of an individual case or problem is completed, there is then the question of the cost that will be justified economically for the desired protection; and finally, with the conditions ascertained and the permissible cost determined, the character of the protective works will depend largely upon the ingenuity and experience of the engineers concerned.

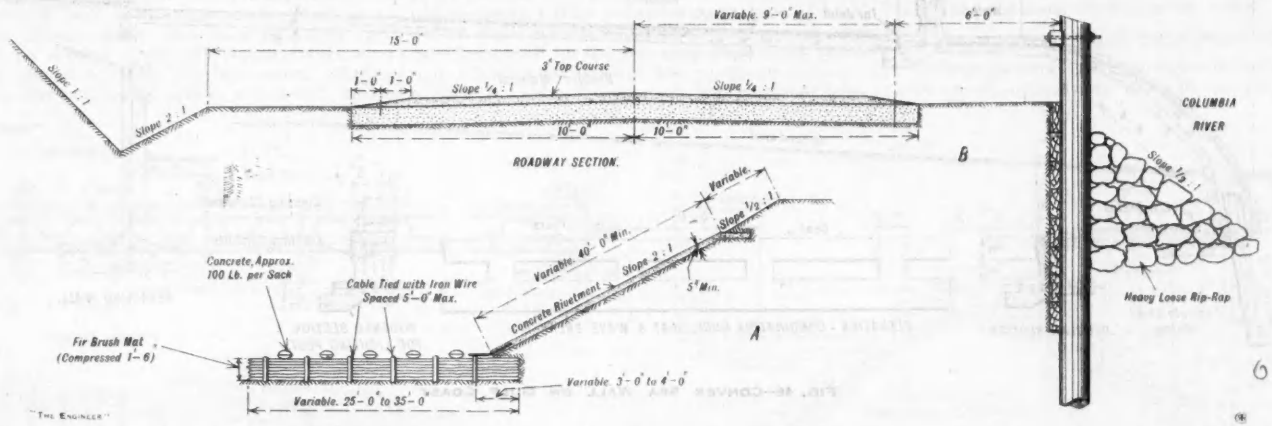


FIG. 49—A. MATTRESS AND CONCRETE REVETMENT AT PUYALLUP RIVER; B. TIMBER WALL ON COLUMBIA RIVER

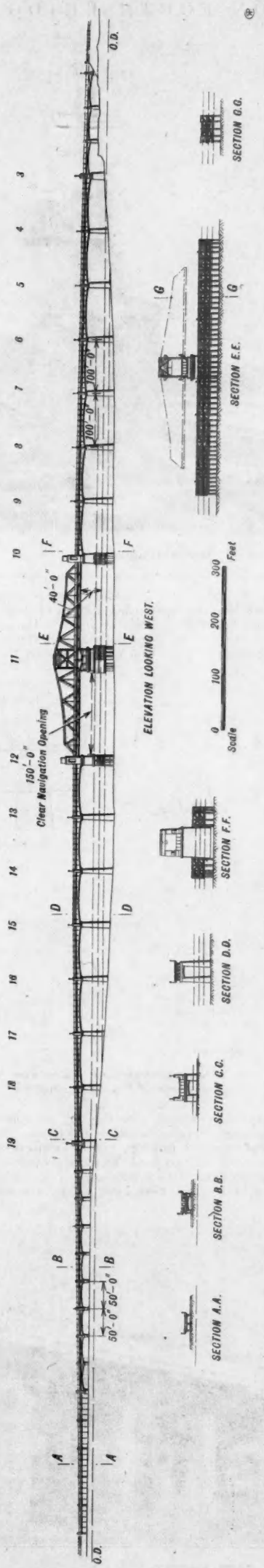
The Kincardine-on-Forth Bridge.

No. I.

AT the present time there is only one bridge of any magnitude under erection in the British Isles. That structure is the Kincardine-on-Forth Bridge, across the Firth of Forth in Scotland. Construction work commenced at the beginning of 1934 and it is expected that the bridge will be opened for traffic next August. The Firth, as a glance at a map will show, by penetrating deeply into the eastern coast of Scotland, cuts off from the south the counties of Fife, Clackmannan, and Kinross. At the present time no road bridge exists across the Forth at a point lower than Stirling, and the Forth railway bridge at Queensferry has formed for many years the only direct means of access between Edinburgh and Dunfermline other than that provided by the motor ferry at the same point. Although the Kincardine-on-Forth Bridge, situated 14 miles west of the railway bridge, is too far upstream to give a really direct route between Edinburgh and Fife, it will, nevertheless, considerably reduce the journey by road, and also relieve congestion at the Stirling Bridge. At present, the distance between Edinburgh and Dunfermline is 57 miles. By the construction of the bridge it will be reduced to 38 miles, or two-thirds of the present distance. The true value of the bridge, however, must be assessed by the manner in which it will facilitate the flow of traffic between the mining areas of Fife, Clackmannan and Kinross, and the industrial districts around Glasgow. As further examination of a map will demonstrate, it is situated on the direct line between these districts.

The bridge, for which Sir Alexander Gibb and Partners are the engineers, and the Cleveland Bridge and Engineering Company, Ltd., the contractors,

DESIGN OF THE KINCARDINE-ON-FORTH BRIDGE, SCOTLAND



crosses the Firth between Kincardine on the Fife shore and Higgins Neuck on the Stirling side, just at that point east of which the width from shore to shore rapidly increases. As it is, the bridge has a length of approximately half a mile, and is one of the longest road bridges in this country. This site was not chosen without a careful consideration of other possible positions. On the one hand, while the construction of a bridge further upstream might have proved cheaper, its importance would have become of a more and more local character the nearer it was to Stirling. On the other, the choice of a site lower downstream where the Firth is very much wider would have resulted in a much higher cost, quite disproportionate to the advantages gained until the neighbourhood of Queensferry was reached. It is significant in this respect that for some years the construction of a road bridge at or near Queensferry has been, and still is, under discussion.

At one time the site chosen, just opposite to the town of Kincardine, was regarded as impracticable, on account of the difficulty of finding foundations on the southern side of the river. As will be seen from the drawing, Fig. 1, showing the situation of the bridge and strata encountered when driving exploratory borings, a fault occurs roughly along the centre of the river bed. On the north side, bores Nos. 7 to 10 all encountered a good grey sandstone, very suitable for foundations at reasonable depths, the greatest of which was 37ft. below O.D. at No. 7 bore. Bore No. 6, however, shows a total change. The same sandstone is not found until a depth of nearly 60ft. below O.D. has been reached, and it is overlain by various soft and loose materials. The sandstone strata slopes, moreover, downwards towards the south, and though it was found at a depth of 78ft. at bore No. 5, the remaining holes were not carried deep enough to reach it. In bores Nos. 1 to 5 uniformly soft or loose material was encountered at depths down to 70ft. or 80ft., and for the first 30ft. to 40ft. the material was composed of soft muddy clay quite unsuitable for any form of foundation. Fortunately, however, there exists at a level between 35ft. and 50ft. below O.D. a layer of hard bound gravel, varying in thickness from about 2ft. to 6ft., and forming a hard strata in contradistinction to those above and below it. This layer of gravel lies at a depth, and has been found strong enough, to be suitable for piled foundations. Fairly stiff clay beneath it gives it stability.

The river is used for navigation as far up its course as Stirling, so that the bridge being at a low level, it was necessary to include a swing span. Vessels of between 2000 and 3000 tons capacity pass the bridge site on their way to Alloa Docks. During the time the bridge has been under construction, about thirty ships per month have passed the site. Navigational interests, having regard to vessels of 4000 tons capacity, fixed the minimum size of the required openings at 150ft. on each side, so that the central swing span, with a total length of 364ft. and a swinging weight of 1600 tons, will, when it has been constructed, be the largest in this country and possibly in Europe. It is fortunate therefore that the fault in the strata of grey standstone occurs on a line to the south of the centre

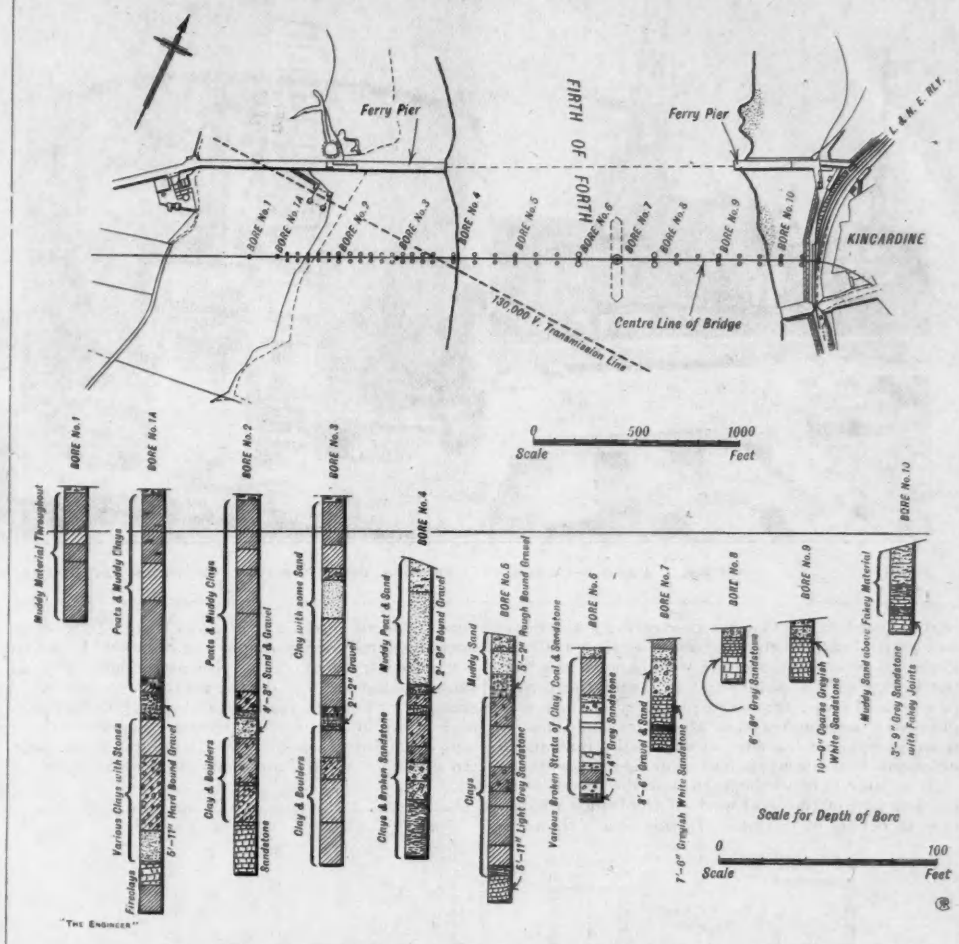


FIG. 1—SITUATION OF BRIDGE AND RESULTS OF EXPLORATORY BORING

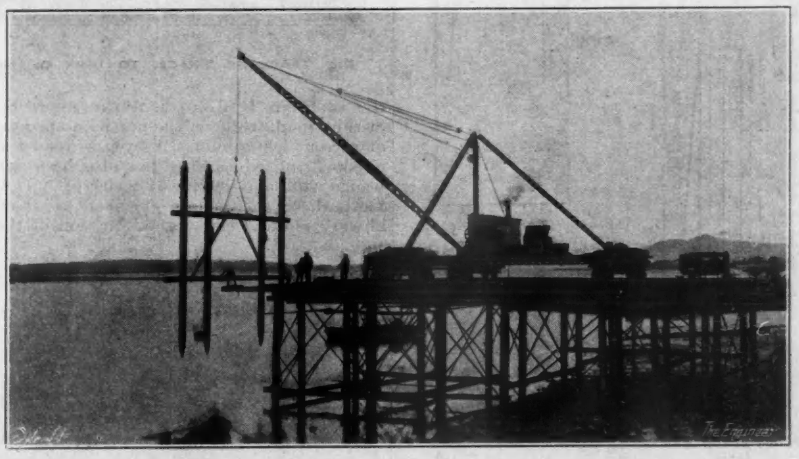
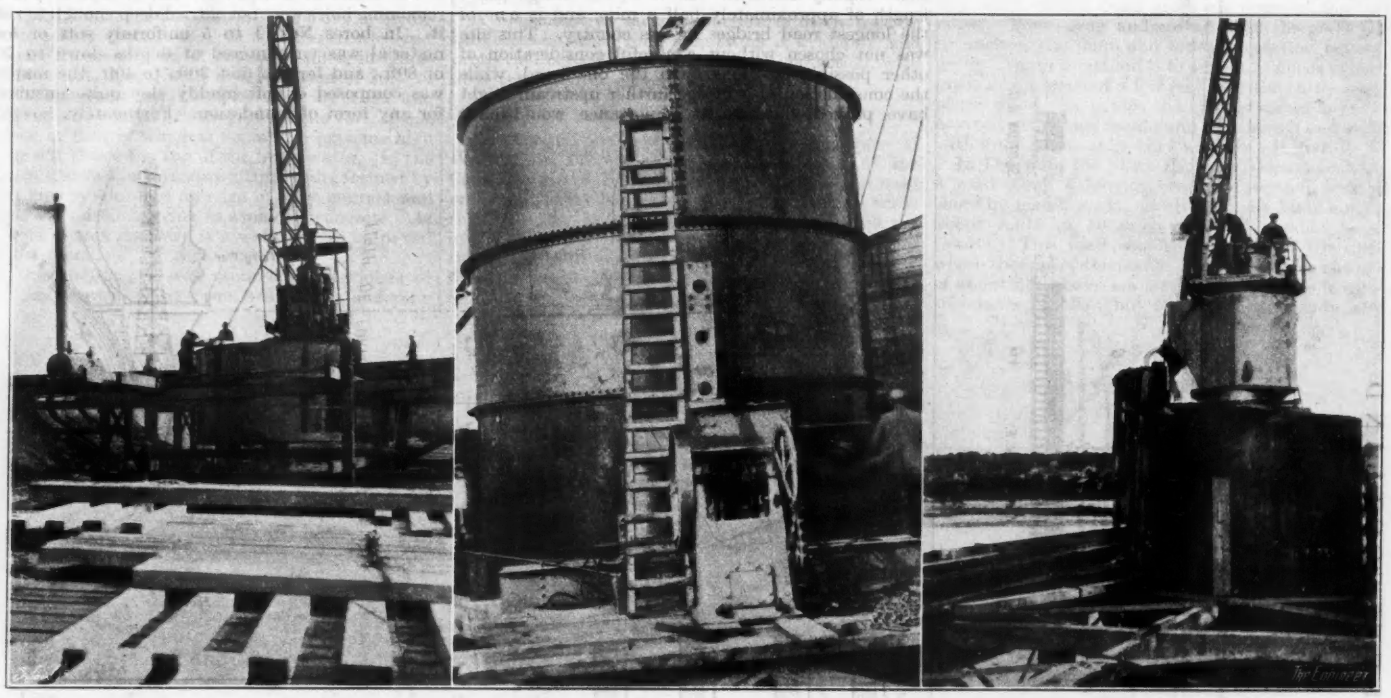


FIG. 2—BUILDING OUT A TIMBER PILE STAGING FROM NORTH SHORE

FOUNDING THE PIERS OF THE KINCARDINE-ON-FORTH BRIDGE



FIGS. 3, 4 AND 5—LOWERING CYLINDER INTO POSITION. CYLINDER ON LOWERING JACKS, AND AIR LOCK

of the river bed, so that the pier carrying the heavy swing span can be founded on the good material. Before, however, the decision was made to construct the bridge at this point, and to found the central pier in mid-river, further exploratory borings were put down to confirm that the pier would not be situated right on the edge of the good strata and to determine that the strata had no dangerous overhang.

At a later date we hope to describe in detail the construction of the steel work of the bridge which is now in course of erection. In this article, however,

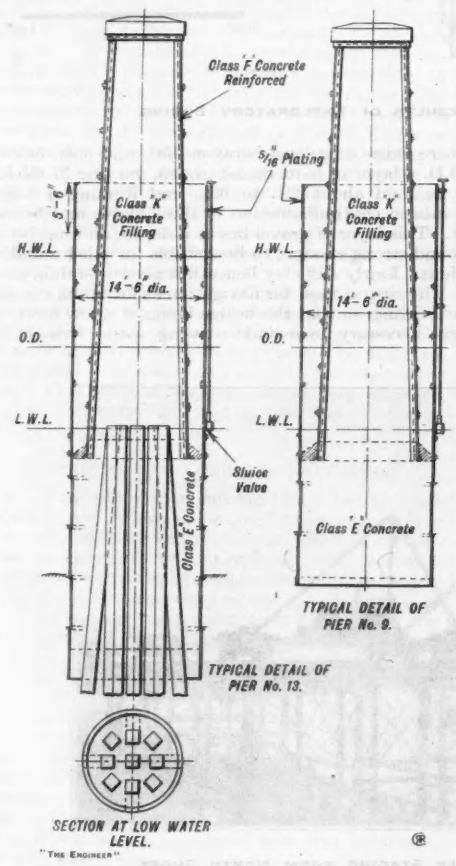


FIG. 6—ARRANGEMENTS OF PIERS AND CYLINDERS

it is intended only to attempt a description of the work necessary to found and construct the piers. Necessarily the difference in the foundation material on the northern and southern banks brought about different methods of founding the piers. While those on the north could be founded in a straightforward manner on the rock, those on the south side had to be supported on piles. Moreover, the unstable marshy nature of the surface soil on the southern side introduced difficulties into the work of construction.

The bridge consists of the central swing span already mentioned, which gives two 150ft. clear openings for shipping, flanked on each side by seven 100ft. steel spans of cantilever construction. Beyond these spans there are on the north three 60ft. steel spans carrying the road over the L.N.E. Railway, and on the south nine 50ft. reinforced concrete spans and a reinforced concrete piled viaduct, 263ft. long. An approach road has already been constructed on

FIG. 7—ACCESS TRACK TO LINE OF BRIDGE

the southern bank to join the main Edinburgh-Stirling road, while on the north an approach road is at present being built. A by-pass road through the outskirts of Kincardine has also been built. The bridge will have a roadway width of 30ft. with a 5ft. footpath on each side. The plan to which we have already referred shows the situation of the piers in relation to the bore-holes and to the shore line on each side of the river. Another drawing on page 197 gives an elevation of the bridge, together with a plan of the central span and cross elevations of typical piers.

Nearly all the piers, it will be seen from photo-

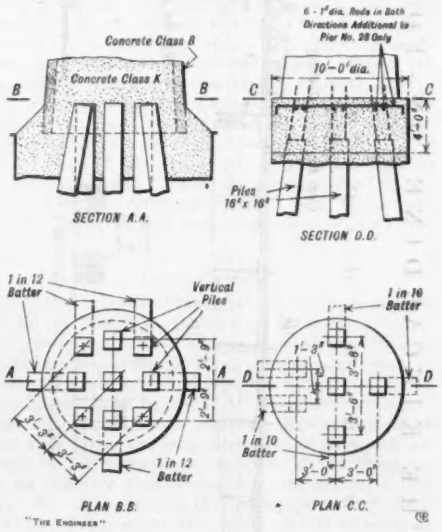


FIG. 9—ARRANGEMENT OF PILES FOR 100 FT. AND 50 FT. SPAN PIERS

graphs reproduced with this article, consist of two tapering cylindrical concrete columns joined by a cross beam at the top, but the central swing span pier and its two flanking piers provide exceptions. These cylindrical columns are identical in all parts of the bridge and were built up by the use of steel

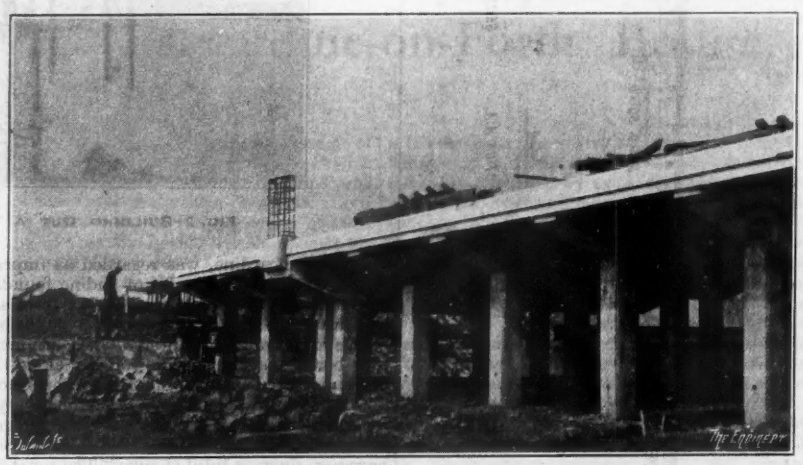


FIG. 8—PART OF THE PILED VIADUCT

shuttering specially designed for the purpose, each steel "ring" being made up in three pieces adapted to be bolted to its fellows and to the rings above and below. The use of this steel shuttering was only made possible by the identical nature of the columns. When the men had become practised in the use of this shuttering the method proved a very expeditious one.

There is no need to describe at length the methods for obtaining suitable foundations on the north side of the river. Piers Nos. 3 to 11 are founded here on the hard sandstone at no great depth. Steel cylinders, 14ft. 6in. in internal diameter, were provided with cutting edges and sunk in the usual manner through the overlying strata to the rock, which was excavated to the extent of about 2ft. to give a good interlock. For the piers Nos. 3 to 5 it was found possible to carry out this work even without the use of compressed air, owing to the amount of soft material overlying the rock, as pumping within the steel cylinder kept the work satisfactorily dry. The remaining cylinders up to those for No. 9 pier were sunk by the help of compressed air, kentledge and water ballast being used to overcome the buoyancy of the cylinders. When sufficient key with the rock had been obtained the cylinders were filled with mass concrete up to a point a few feet below low-water level. Thereafter the concrete column was built up within the protection of the extension of the cylinder to a sufficient height above high-water level. The upper part of the cylinder was then removed, the remainder from a point about 3ft. below low-water level being left in place. The whole operation is illustrated by the line engraving Fig. 6, and views of the work in progress are reproduced in a number of half-tone engravings. Pier No. 9, which was the first to be founded by compressed air, was completed in December, 1934, and the remainder, working back towards the shore as far as pier No. 3, were finished by May, 1935. The sites of the piers were reached by building out from the north shore a staging of timber piles, a bent for which being carried into position being shown in Fig. 2. In the engraving Fig. 3 the lowermost section of the upstream foundation cylinder for pier No. 3 is seen being lowered into position ready for sinking. Another engraving, Fig. 5, shows an air lock in position on the top of one of the pneumatic caissons for pier No. 9. The operation of pumping in water for kentledge purposes is in progress. In another engraving, Fig. 10, the reinforcing bars for the upper parts of pier No. 4 are to be seen, together with the cylindrical steel shuttering. When the piers had been built up to a sufficient height reinforced concrete cross beams were formed by the use of the steel shuttering shown in Figs. 11 and 12. The foundations for the north abutment and piers Nos. 1 and 2 were obtained by driving reinforced concrete piles, 16in. by 16in., to rock about 20ft. down. The foreshore at this place is reclaimed material and is unsuitable for carrying any heavy loads.

FIG. 10—CYLINDRICAL SHUTTERING AND REINFORCEMENT FOR CONCRETE PIERS

FIG. 11—PIER NO. 9 COMPLETED: SHUTTERING ERECTED ON PIER NO. 8

On the southern side the contractors were faced by a difficulty which at one time threatened to be a formidable obstacle to the construction of the bridge. The nature of the surface soil on this side of the river can be partly judged from the photographic view reproduced in Fig. 7 and by the picture taken at a much later date and reproduced in Fig. 17, p. 204. The immediate surface at this point is composed of soft muddy clay and peat. No hard material, however, underlies the peat until quite considerable depths, and piles for the temporary staging were found to sink their whole length almost by their own weight alone. Driving them was rather like forcing a match into soft butter with a carpenter's hammer! A solution to the problem was found by the construction of a timber staging with a very wide bearing area, which, so to speak, floated on the peat surface and carried a special steel transportable structure used for driving the permanent bridge piles. This staging was carried far out into the river in this manner. The timber staging and the pile driving structure are illustrated on page 204. The first work carried out was that of driving the piles for the piled viaduct which constitutes the approach on this side. Precast concrete piles, 65ft. by 18in. by 18in., were used, driven by a 5-ton hammer to a set of 1in. to six blows, and no more attention need be given to this work in this article than to direct the reader's observation to the half-tone engraving, Fig. 8, which shows part of the viaduct partially completed, and to Fig. 13, which shows one of the piles in the course of being placed in position. The number of piles required to be driven in all foundations when the bridge is complete will be 482.

A typical section of one of the columns for a 100ft. span pier, together with the steel cylinder in which it was built, is reproduced in Fig. 6. In founding these piers the cylindrical caisson was first lowered into position—the term "driven" can hardly be used, as the ground was so soft. The pile driving "bridge" was then brought into position and pre-cast concrete piles, 18in. by 18in., driven to their set within the cylinder. For the 50ft. spans six piles were driven, arranged as shown in Fig. 9. All except the central pile were driven on a rake to give stability to the foundation. Nine piles, five on a rake, were used in each cylinder for the 100ft. spans, as shown in this engraving. When the piles were all in place a concrete cap was laid to the full diameter of the cylinder to bind the heads of the piles together. Reinforcing bars were embedded in this cap to "key" with the concrete laid above. From this point the cylindrical column was built up with the steel shuttering in exactly the same manner as that adopted for the piers on the northern side. In Fig. 15 work is seen in progress on the driving of piles at pier No. 18. The lowering of a temporary cylinder is illustrated in Fig. 4, while the piles within a cylinder can be seen in Fig. 14.

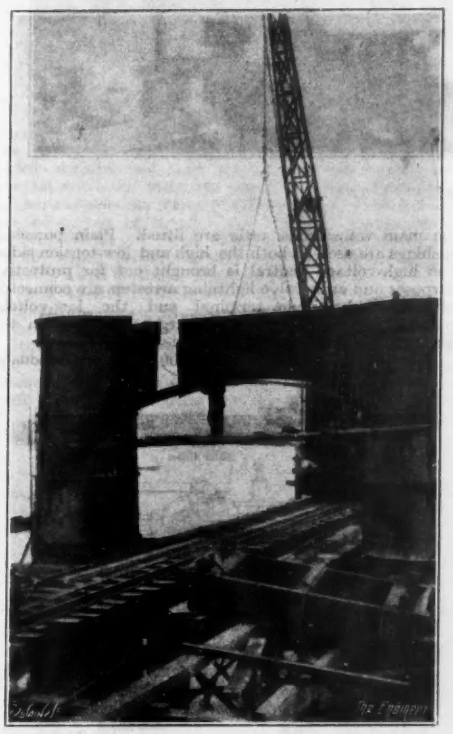


FIG. 12—ERECTING SHUTTERING FOR PIER NO. 9

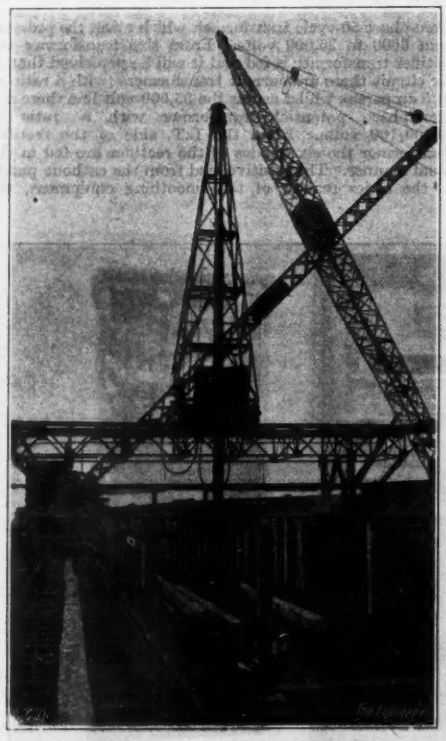


FIG. 13—DRIVING PILE FOR PILED VIADUCT

FIG. 14—PILES DRIVEN IN CYLINDER FOR PIER NO. 17

(To be continued.)

THE French Court of Indictments has ordered that the hulk of the "L'Atlantique" shall be formally handed over to the Sud-Atlantic Company. It is reported that the hulk will be sold to ascertain its value for the purpose of indemnifying the salvage companies.

3300-Volt Rectifier Sub-Station Equipment

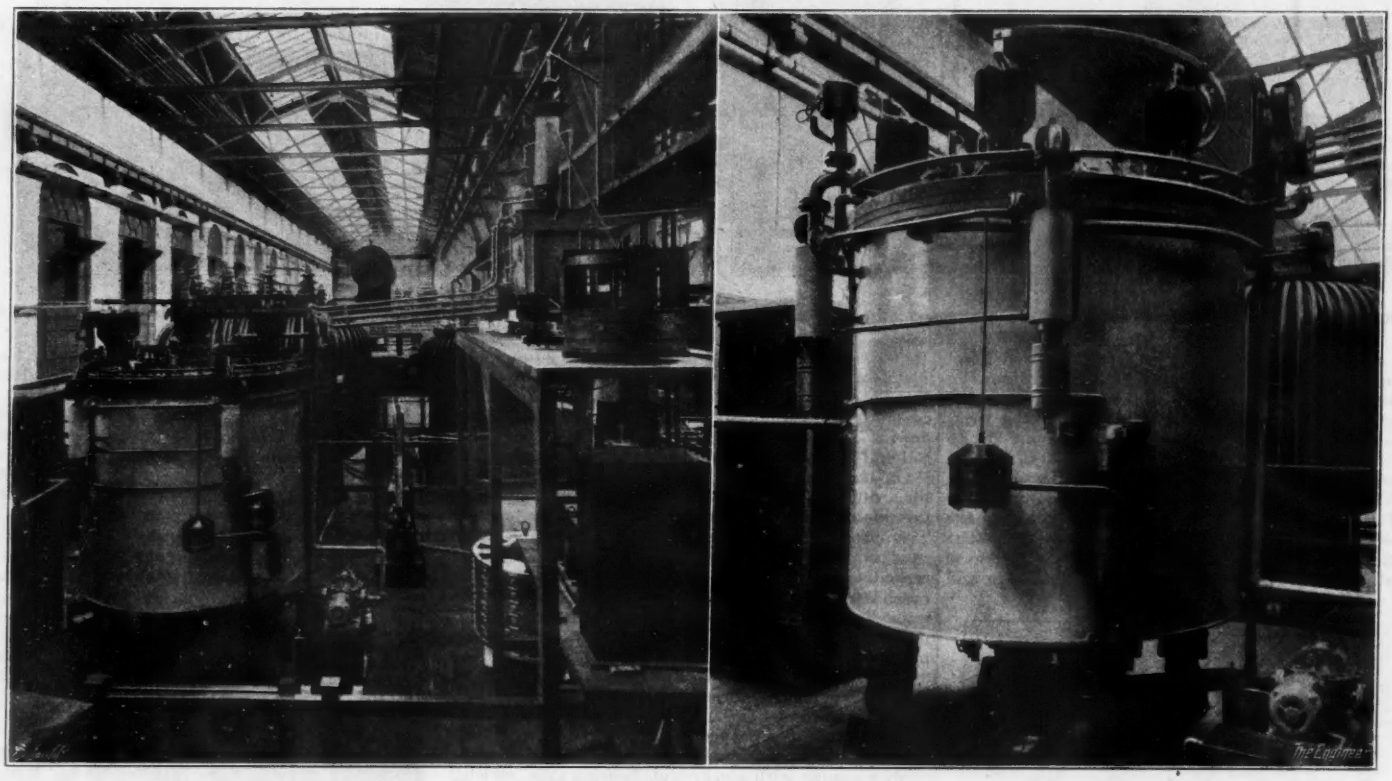
DESPITE the somewhat hostile reception which steel tank rectifiers received when they first threatened to reduce the demand for rotary converters, it soon became apparent from progress on the Continent that their adoption on an extensive scale was inevitable. Steps were therefore taken by several British firms to cater for the new business. No better proof of the success that has attended the efforts of some of these firms has been afforded than the satisfactory report on the performance of rectifiers given by Mr. A. L. Lunn in his paper read before the I.E.E. in November of last year. Compared with rotaries, metal-cased rectifiers have been found to offer distinct advantages on the London underground railways, which have benefited, for example, by the rapidity with which the D.C. supply can be restored after a failure on the A.C. side. But it is well known that from the point of view of efficiency mercury arc rectifiers give the best results when the D.C. output is at a relatively high pressure, such as 3000 volts. In this country there is at present no inclination to exceed the low pressure that can be applied to a third rail. For distances greatly exceeding those covered electrically 1500 volts is the pressure in view. But abroad there is an increasing demand for traction rectifiers giving 3000 volts, and the English Electric Company, Ltd., of Stafford, is one of the firms catering for it. As far as rectifiers are concerned, this pressure might be considerably increased without difficulty or danger. It is the train equipment that limits the pressure to 3000 volts, and it remains to be proved that this is the best for all long-distance railways, as some engineers have apparently concluded.

At the Stafford works of the English Electric Company we recently inspected the 2000-kW, 3300-volt remote controlled rectifier equipment shown in the accompanying illustrations. It was erected in the works to represent a modern steel tank rectifier sub-station. It is being supplied to Poland.

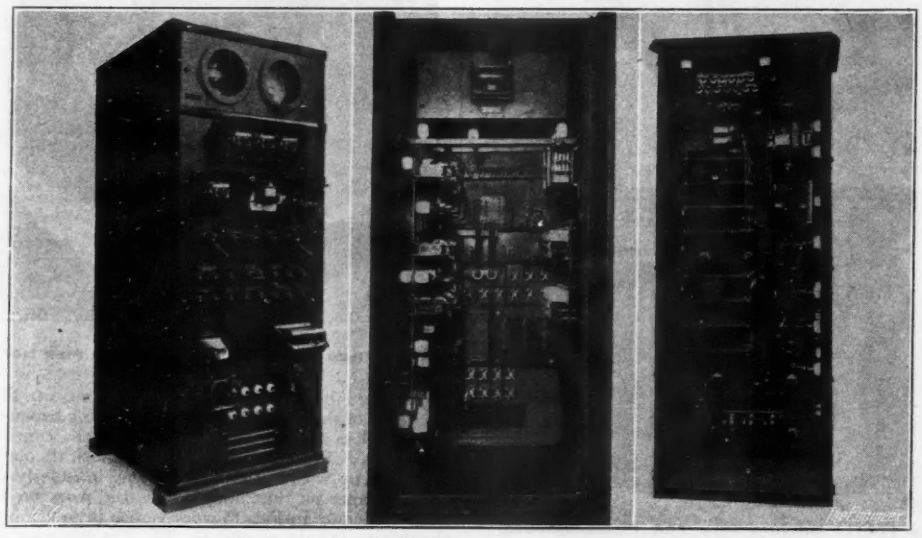
The main diagram of connections enables the units to be identified and it indicates the wiring arrangements at the Stafford works, in which short-circuit and other tests have recently been made. Power from the Corporation's mains is supplied through an oil switch to a three-phase 50-cycle transformer, which raises the pressure from 6600 to 35,000 volts. From this transformer the rectifier transformer is fed and it will be perceived that in the circuit there are current transformers (with a ratio of 50/5 amperes), whilst across the 35,000-volt line there is a three-phase potential transformer with a ratio of 35,000/100 volts. From the L.T. side of the rectifier transformer the six anodes of the rectifier are fed in the usual manner. The positive lead from the cathode passes to the series reactor of the smoothing equipment, the high-speed breaker, and finally to the plates in the loading tank, the equipment operating with the cathode at the full potential of 3300 volts above earth.

From the neutral of the fork-connected transformer winding the negative lead is connected to the earthed side of the loading tank with an ammeter in circuit. Four resonant shunt circuits are connected across the 3300-volt D.C. circuit immediately after the series reactor. While the primary windings of the three-phase core type oil immersed natural cooled rectifier transformer are connected in star the secondary windings are connected in the double zigzag or fork fashion to provide six-phase current. The high-voltage winding outside the low-voltage winding consists of helical disc coils with a single turn per layer and with an oil space between each pair of coils. The low-voltage winding takes the form of a spiral coil arranged so that all phases have the same reactance to the primary, thus ensuring that the load is equally shared and that in the event of a backfire on one phase the axial stresses will be evenly distributed across the entire flat surface of the winding. The turns are separated by radial oil spaces. As indicated in the diagram, there is a third winding for braking out. This consists of a disc coil at the bottom end of the high-voltage column of each limb, the middle of each coil being tapped and connected to the neutral lead, so that the coils form a six-phase double star-connected winding. Expansion vessels, silica-gel breathers, dial thermometers, oil gauges, drain valves, and tapping switches for giving small variations in the main transformer ratio are fitted. Plain porcelain bushings are used on both the high and low-tension sides. The high-voltage neutral is brought out for protective purposes and auto-valve lightning arresters are connected between each anode terminal and the low-voltage neutral to limit the effect of surges generated in the winding by quick stopping and re-starting of the arc.

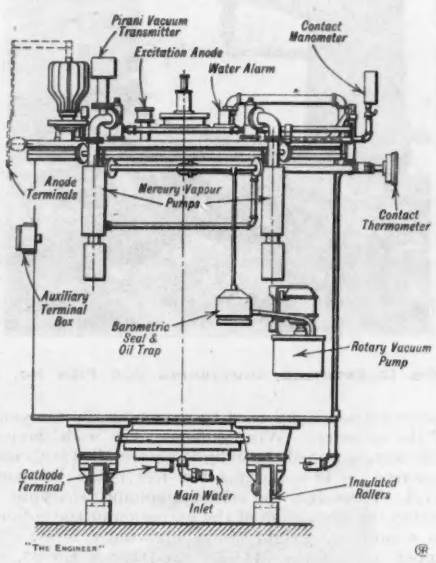
Rated to give 2000 kW at 3300 volts continuously, 25 per cent. overload for fifteen minutes, and 200 per cent. momentarily, the six-phase rectifier operates with the anodes burning over a period of 60 deg. Although for the time being the rectifier is to operate in the ordinary manner with plain characteristics, grids are fitted in the arc path for such control as D.C. voltage variation or grid switching, if necessary. Under normal conditions the grids will be energised by A.C. voltage bearing a certain phase relationship to the anode voltage from an auxiliary transformer housed in the excitation unit and connected to the 220-volt auxiliary supply obtained from main A.C. bus-bars *vid* a step-down transformer.



RECTIFIER SUB-STATION EQUIPMENT ERECTED IN WORKS



RECTIFIER CONTROL CUBICLE AND EXCITATION CUBICLE



GENERAL ARRANGEMENT OF RECTIFIER

But for convenience in the works the correct phase relationship of the grid exciting voltage with respect to the anode voltage was obtained by temporarily connecting the primary of the grid transformer in delta and supplying it from the "braking out" winding, which is diametrically connected, an arrangement giving approximately 70 per cent. of the grid voltage which will be obtained under normal conditions.

The Pirani electrical vacuum indicating equipment consists of a transmitter or detector in the rectifier vacuum pipe line and an indicating instrument reading directly in microns ($^1/_{1000}$ mm. Hg.) fitted in the control cubicle.

Two three-stage diffuser mercury vapour pumps, each connected to the rectifier and to a common pipe line on the output side leading to the barometric seal and preliminary rotary pump, give the vacuum, the manometric seal being a 760 mm. column of mercury between the mercury vapour and rotary pumps. It protects the vacuum chamber from an influx of air and gases when the rotary vacuum pump is shut down, and is combined with an oil trap to prevent oil coming into contact with the mercury. A small single-phase transformer supplies the mercury vapour pump heaters, which are connected in parallel and consume approximately 24 amperes at 60 volts. The preliminary rotary vane pump, which provides a low backing pressure for the mercury vapour pumps is submerged in oil, and is driven by a 0·45 H.P., 1400 r.p.m., 220-volt motor taking its supply from the auxiliary circuit.

A metal oxide rectifier giving 15 amperes at 75/80 volts provides the "excitation" or maintaining arcs, in the rectifier, which has two fixed excitation anodes diametrically opposite to each other and near the ring of main anodes. A central movable anode serves as the ignition device. When the excitation circuit is energised the central anode is drawn down to the mercury cathode by a solenoid, and is then returned to its normal position by a mercury float when an arc is struck, and transferred to the excitation anodes. The total excitation current on light load varies between 10–11 amperes, and 13–14 amperes on full load. D.C. excitation is very stable and enables the main arc to be maintained down to about zero load. Since the excitation circuit is at approximately the rectifier potential, the transformer supplying the metal oxide rectifier is specially insulated to serve as an insulating transformer for the circuit.

Losses in the rectifier are dissipated mainly by a closed water cooling system, but the anodes are cooled mainly by conduction through their stems to the finned coolers on top. The circulating pump for the main cooling circuit is mounted on the floor near the rectifier. It is a horizontal pump driven by a 1 h.p., 1400 r.p.m. motor, with the insulating transformer mounted nearby. Water from the pump enters the cooling chamber at the base of the cathode and passes to the internal annular coolers within the vacuum tank, then to the cooling chamber on the other side of the anode plate, and finally to the water jacket surrounding the vacuum tank. Heated water passes to the recooler, from which it is again drawn in by the pump. A pressure gauge fitted with electrical contacts is placed in the water circuit between the cathode and internal coolers, and in the event of failure of the water circulation it trips out the equipment. A dial thermometer with electrical contacts is fitted to the outlet water pipe, and serves for controlling the recooler fan in accordance with temperature.

The main recooler unit consists of a group of finned radiator tubes assembled between headers in a rectangular housing, and air is forced over the tubes by a centrifugal blower driven at floor level by a 4 h.p., 700 r.p.m. motor. The recooling unit is at the rectifier potential, and is mounted on insulators, but an insulating section in the air trunk enables the fan chamber, trunking, and driving motor to be at earth potential. For cooling the water circulating in the mercury vapour pumps there is a horizontal auxiliary recooler arranged to blow the air stream vertically. The construction is generally similar to that of the main cooler. A 1 h.p., 1400 r.p.m. motor drives the fan and circulating pump, and the whole unit at rectifier potential is mounted on insulators. The motor is supplied by a small insulating transformer mounted by the side of the unit. In the event of failure of the circulating water through the pumps, a pressure gauge in the pipe circuit trips the equipment out of circuit with the aid of electrical contacts.

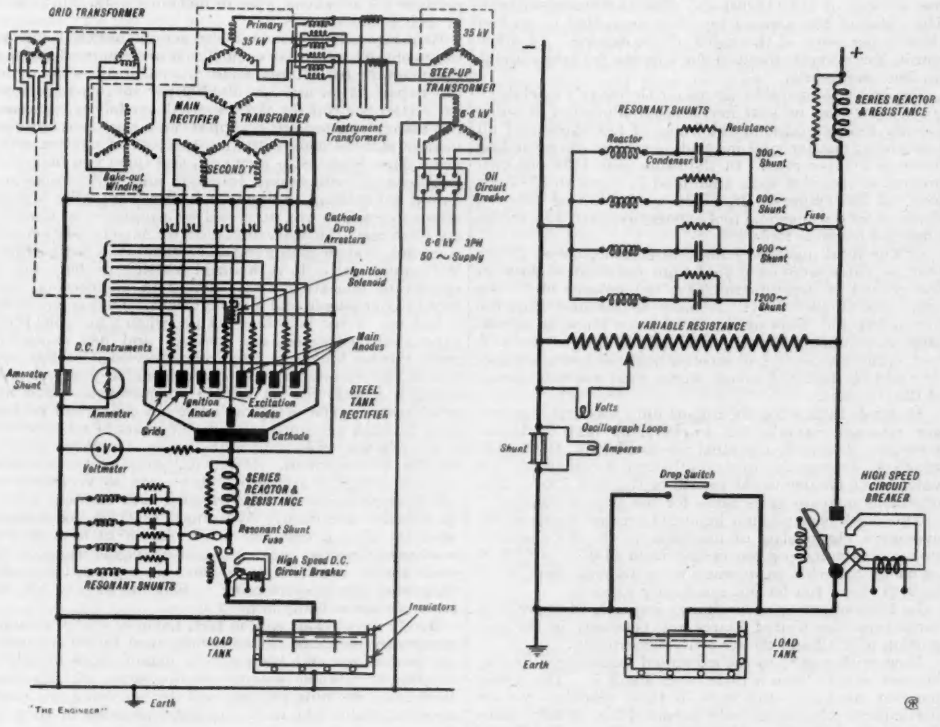
By means of the smoothing circuit the voltage ripple on the D.C. side is limited to 1·5 per cent. (R.M.S. value) of the D.C. voltage with a sine wave supply at the primary terminals. The smoothing equipment consists of a 3 mh series air core reactor connected in the rectifier positive lead, together with four resonant shunt circuits tuned to frequencies of 300, 600, 900, and 1200 cycles per second. Each resonant circuit is made up of a reactor and condenser in series, and the four circuits are protected by a H.T. fuse. The reactors are in two sections, which enable the inductance to be varied by varying the distance between them.

On the front of the short steel rectifier cubicle there are mounted the various instruments and control relays, &c., for the automatic starting of the rectifier and its associated equipment. The automatic vacuum-indicating and control instruments, together with the excitation ammeter, are all at a potential of 3000 volts above earth, and are mounted at the top of the cubicle and behind glass windows. All other high potential devices are mounted inside the cubicle, and are insulated from the low-tension control circuits by small separating transformers.

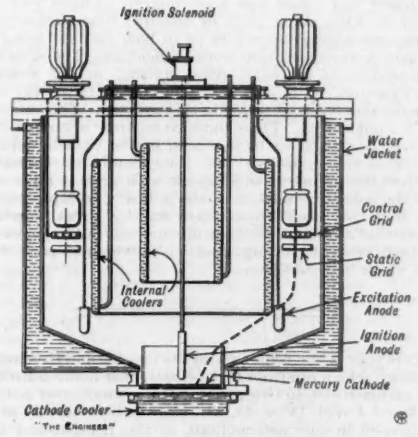
Normally, the starting sequence is initiated by the closing of the main extra high-tension circuit breaker, when the vacuum and recooler pumps and starting excitation circuits are completed automatically in the correct sequence. The last operation is the closing of the D.C. high-speed circuit breaker, which only occurs if everything is in order for taking the load. Normally, the equipment is shut down by opening the main E.H.T. oil circuit breaker, but in the event of a fault developing either during starting or running, the equipment is shut down automatically and an indication of the cause is given by the annunciator device in the centre of the panel. The faults that cause shut down and lock out include failure of vacuum and water circulation, excessive temperature, and incomplete starting sequence. At all times the vacuum pumps are under the control of the vacuum-control instrument, and a high degree of vacuum is ensured. The fan of the main recooler is under automatic water temperature control. Control switches on the panel are not normally operated, and are only provided for testing, &c. The excitation unit contains the metal oxide rectifier and transformer for excitation, the resistances in the excitation circuits, the insulating transformers for the mercury vapour pump, heaters, and the rotary vacuum pump. It also contains the grid excitation transformer.

Although in testing the equipment feeder limitations made it impossible to work with a load more than about one-quarter of the full load during normal working hours, the cathode was at the full potential above earth.

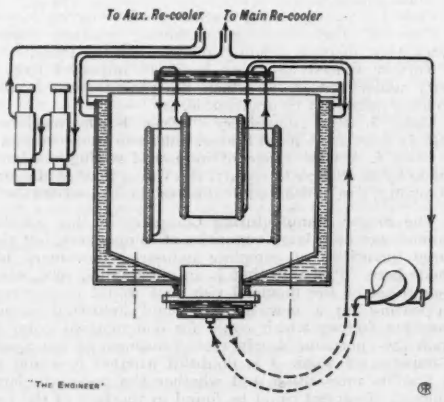
Demonstrations given at the Stafford Works last week included the automatic working of the main recooling apparatus with the rectifier operating with full load current, but reduced D.C. voltage; the starting operation, including the closing of the high-speed D.C. circuit breaker, the operation of the rectifier protective devices, and short-circuit and load tests. Whilst the rectifier was on open circuit at full volts a dead short circuit was applied by the drop switch indicated in the diagram showing the short-circuiting connections. For the test at full voltage and approximately one-quarter the normal load, the water loading tank was employed.



RECTIFIER CONNECTIONS AND SHORT CIRCUIT TEST CONNECTIONS



SIMPLIFIED SECTION OF RECTIFIER



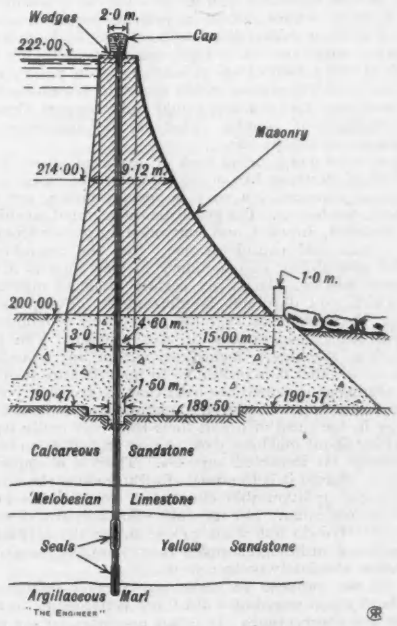
WATER COOLING CIRCUIT

Reinforcement of Gravity Dams.

IN the *Annales des Ponts et Chaussées* for last August there appeared a full description of the very ingenious method invented by Monsieur Coyne for adding to the downward pressure of a gravity dam. Briefly, this method consists in drilling a number of vertical holes from the crest of the dam right through the whole structure and deep into the underlying strata. Cables of a special construction are dropped down these holes and their lower ends firmly anchored with cement, whilst the remainder of the length is left free in the holes. A suitable device then puts a tension on the cables and as soon as the desired load is reached a cap of concrete makes the upper end secure. Thus the cables, by the tension set up in them, increase the effective "gravity" of the dam.

This plan has been adopted for the reinforcement of an old barrage in Algeria, the "Cheurfas," which, despite attempts to preserve it by lowering the height and increasing the length of the overflow weir, was giving anxiety. It is 30 m. in height, in masonry on a concrete bed, as shown in the accompanying section, and was built in 1880–82 for irrigation purposes.

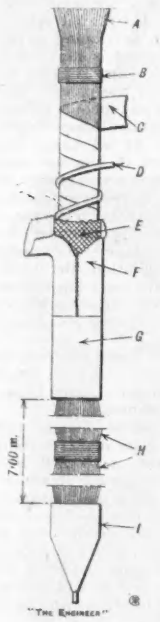
Monsieur Coyne's scheme was carried out by drilling thirty-seven vertical holes at 4 m. centres and applying a load of 1000 tons on each cable. The increase of "gravity" thus effected has enabled the barrage to be raised by 3 m. Each hole is 25 cm. in diameter and enters the foundations to a depth of 23 m. The cable, shown diagrammatically, is composed of 630 steel galvanised wires, 5 mm. diameter, laid parallel and sheathed in the



REINFORCEMENT OF CHEURFAS BARRAGE

manner indicated by the legend beside the sketch below. In the centre of the bundle of wire a tube 25 mm. in diameter is included for the injection of cement grout. The cables were made over the holes they were to occupy in a device, of which the essential is a group of thin steel capping plates superposed and each pierced with 630 holes arranged in circles decreasing in diameter through which the wires were threaded.

As soon as a cable was complete in its hole water was pumped down the central tube until it arose clear to the surface, between the outside of the cable and the sides of



A.—630 galvanised steel wires.
B.—Ligatures at every 50 c.m.
C.—Impregnated sail-cloth wrapping.
D.—Binding cord.
E.—Elastic covering of grease and bitumen.
F.—Sheath in sail-cloth.
G.—Cement plug closing covering upon the wires.
H.—Wires opened out for sealing.
I.—Cast white-metal nose piece.

the hole. Cement grout, equal parts of cement and water, was then pumped down the tube till it also showed at the surface. By this method the only part of the cable secured by the grout is the naked part at the lower end, whilst the remainder can stretch inside its elastic covering.

At the top also the wires are left bare, are spread out equally, and embedded in a rich concrete under vibration. The tension is applied to the cable by three hydraulic jacks of 400 tons capacity, which act between the capping plates already mentioned and suitable bearing plates. As soon as the necessary tension is attained special packing pieces are inserted under the capping plates and the whole finished off.

Machinery and the Nation.*

By D. A. BREMNER.

To speak about machinery and the nation requires little or no excuse, because if you imagine for one moment that this country of ours had all its existing potential sources of food and raw materials to support human life on a considerable scale and at a high standard and you then deprived the nation of all its machinery, in a very short space of time the nation would revert to a semi-barbaric existence and the country would only support three or four millions of people. That is the significance of machinery in modern life

Now, machinery, being such an essential factor in the support of anything like a good standard of living in the nation, is necessarily a very important factor, not only in peace, but in war. The peace manufacture of machinery is stimulated, directed, and controlled by purely economic and commercial considerations. But the manufacture or the availability of machinery in war time is a very different matter. There are certain kinds of machinery for which you dare not be dependent on any foreign Power. In these cases, therefore, the purely economic and commercial considerations do not prevail. You must have that machinery regardless, within any reasonable limit, of whether it is profitable to manufacture it or not. The argument is sometimes used that we are in any event so dependent upon imported foodstuffs and imported heat energy in the form of liquid fuels that it is really no use worrying about machinery or making any effort to be less dependent on imported supplies. That is a counsel of despair. Surely it is the duty of all to reduce the already very large unfavourable chances of war to the lowest possible minimum. Let us make efforts in any direction we can. We do not want to encourage the attitude of dependence on foreign supplies more than the facts of the situation absolutely dictate to us.

I do not propose to make any further reference to machinery and war, but I did think it necessary to make these few observations. It is not necessary to say more, at this stage at any rate, because, in my opinion, if we do many of the things which it is quite possible for us to do in the way of developing our machinery manufacture we shall automatically and incidentally have done a great deal towards fitting ourselves to supply the machinery required in war time. Therefore we can for our immediate purpose direct our attention to the manufacture of machinery in peace time. Having regard to the vital importance of machinery in peace and war, it is necessary to take a look at the present position of our machinery manufacture and trade.

But in order that there may be no legitimate misapprehensions or criticisms of my remarks I wish to say that I do not for one moment suggest any such wild idea as that we or any other nation should aim at 100 per cent. self-sufficiency in the invention, design, and manufacture of machinery. It is not only impossible, but it is very doubtful if it would be desirable. We are not always at war, for one thing. The decisive consideration is that we find distributed over the various civilised countries of the world a vast amount of inventive genius, a capacity for design and resources for the development of perfectly wonderful machinery. The idea that you can get down into a bolt hole and pull the lid down after you is absurd. One hundred per cent. self-sufficiency is not a thing desirable or a thing to aim at. Having made that reservation, I now say that there are very great and very serious gaps in our machinery manufacture which, to the best of my knowledge and judgment, can and should be filled. Let us just look at the facts. I have here a few figures to which I crave your attention, because they provide in a large measure the solid structure on which my arguments are based. Our imports and exports of machinery in 1935 had a value of £13,144,000 and £38,495,000 respectively. The value of the imports therefore amounted to no less than 34 per cent. of the value of the exports. In other words, for every £ received for exports we spent about 6s. 10d. on imports.

The latest comparable figures for Germany's machinery trade show that in 1934 her imports amounted in value to only 9·7 per cent. of the value of her exports of all machinery, and for machine tools alone the corresponding figure is 7·1 per cent. In the same year 1934 our own imports of machine tools amounted in value to 87·5 per cent. of the exports. In other words, out of every £ received for our machine tool exports we spent 17s. 6d. on imported machine tools.

Of our total machinery imports in 1935, about 23 per cent. in value were exempted from payment of duty on the ground of non-procurability, the balance of 77 per cent. paid import duty. It must be assumed that the purchasers and users of this machinery found it advantageous to import it even with duty added to the c.i.f. cost, either because it had superior qualities or was cheaper or could be delivered sooner where time was the essence of the contract.

In April, 1932, when the import duty was first imposed, our retained imports fell to £679,000 and fluctuated thereafter, but with a gradual rise until July, 1933, after which the average line rose rapidly until it culminated in a value of £1,170,000 in the month of October, 1935. This enormous increase gives cause for the gravest concern.

This machinery was not imported because it was on the average a cheap class of machinery. On the contrary, its average value per ton ranged from £149·5 to £259·6, as compared with an average value ranging from £97·9 to £101·1 per ton for our machinery exports.

In 1935, of our total machinery imports, 74·2 per cent. came from the United States and Germany in the proportion of 45·2 and 29 per cent. respectively.

Now, with regard to the exempted machinery; it may interest you to learn a little more about it. The special purpose machines—and it is in these machines we are particularly weak—regularly imported free of duty under licence which could and should be made in the United Kingdom, are :—

Class 1. Button machinery: blanking presses, turning, milling, drilling, and polishing machines.

Class 3. Dry battery machinery: zinc can rolling machines, dolly wrapping and tying machines, dolly presses.

Class 4. Textile: warp tying machines, flat bed knitting machines, ribbon looms.

Class 5. Electric lamp and radio valve machinery: sealing and exhausting machines, capping machines, mounting machines, inserting and button making.

Class 7. Butter moulding and wrapping machines, cheese wrapping and labelling.

Class 9. Wax spraying machines, wire stitching machines, book sewing machines.

Class 10. Die casting machines (automatic and semi-automatic).

Class 11. Spring coiling machines, wire weaving looms.

Class 15. Gut cleaning machines, crustless cheese machinery, melting, refining, mixing, and kneading.

Further special machines regularly imported free of duty under licence, of which the manufacture in this country might not be practicable, are :—

Class 5. Glass machinery: glass bottle machines, mainly from the United States, but some from Germany.

Class 4. A wide range of industrial sewing machines made by the Singer Company, the Union Special Machine Company, and Wilcox and Gibbs, of the United States.

The Singer Manufacturing Company in this country imports not only large quantities of components, but also large quantities of complete industrial machinery not made here. Probably that is an outstanding case, when you think of the financial risk that would be involved in setting up a new domestic and industrial sewing machine factory which could for one moment compete with the enormous deeply rooted business of the Singer Company. I think it is doubtful whether it would be a feasible proposition and whether the necessary large amount of capital could be found in the face of the risk involved.

You may be surprised to know that if you pick up one or two representative engineering journals and turn over the advertising pages, you will find a large amount of foreign machinery advertised which evidently finds sufficient sale in this country to justify the outlay of very large sums on advertising. Let me quote a grab sample taken at random :

German: Vertical boring mills, special grinding machines; hydraulic shaping machines and tool grinders; tube extrusion presses; tube rolling and welding machines.

U.S.A.: Pipe threading machines.

German: Large forging presses; electric coal drills, arc welding sets; rolling mill plant; scrap bundling presses; rolling mills; rolling mills, electric furnaces, gearing, air compressors, pneumatic tools, cranes; pneumatic tools.

Swedish: Centreless grinders.

German: Grabs; rolling mill plant; cranes, propeller pumps; dry ice plant; aerial ropeways; diesinking machines.

I have already made it clear that I do not suggest that we should try to be 100 per cent. self-sufficient, but in view of this bold outline picture I do say that the position of our machinery manufacture requires to be looked into. I suggest that it is extremely desirable to develop the manufacture of the higher classes of machinery. You have heard it before. But you cannot get away from it. Unless you develop in the higher classes of machinery requiring great skill in design and construction and in salesmanship; unless you develop on these lines you are gradually going to slide down the hill. Unless you develop the higher classes of machinery manufacture in this country you are not going to be able, by any strenuous efforts whatever, to meet the requirements of modern warfare, because modern warfare, with its extremely scientific and highly advanced forms of munitions of war, calls for a very high degree of skill in manufacture and for a very high class of production machinery which you cannot improvise when the event is upon you. Even in peace times a great, old engineering country like ours must keep up with the procession and must produce the advanced types of machinery and must excel in their production.

Remember, however, the very serious national emergency consideration that even if you are equipped for the manufacture on a large scale of machinery which you can export at an average of £100 per ton, as compared with £180 per ton for the imported machinery, you are not ready, you are not equipped, and you have not the manual skill to cope with the demands of modern warfare. That leads us to *personnel*, and there you have the questions of education, training, and apprenticeship. I need not attempt to dwell upon them here. We cannot afford to wait, as was suggested by a professor at a meeting I attended the other day, until we have revolutionised our whole system of training and education in engineering. We cannot wait. It is doubtful whether we have not a system of education and training in engineering well fitted to our people and our conditions. That is not what is lacking. What is lacking is that, when a man has been expensively educated and trained, and has expended great mental labour in acquiring knowledge of his profession, he cannot be sure of a reasonable prospect and security of enjoying an income commensurate with his attainments. The mechanic must not find when he has gone through an apprenticeship and years of toil that his brother-in-law is earning more money punching tickets on the Underground. Moreover, your skilled workers are not going to apprentice their sons to vocations in which employment is very irregular and earnings correspondingly uncertain. We must establish conditions whereby when a man has fitted himself to be a skilled mechanic, designer, constructor, or managing engineer, he shall find it worth while to have so equipped himself. Otherwise you are not going to find the men to fill the ranks we are so badly in need of.

Surely the obvious and, in fact, the only way of providing greatly increased skilled employment in the engineering professions and trades is to manufacture ourselves the largest possible amount of the kinds of high-class machinery we now import, and by so doing we shall also materially add to the national security in time of emergency.

The next thing is the organisation of the engineering industry of to-day. I would rather use a new term—"engineering" is too wide and comprehensive—and call it the machinery-manufacturing trade. We need to create something worthy of the name of organisation. We must have a concerted policy, taking account of the future trend of manufacture, and it must be conducted on sensible lines worthy of the class of brains engaged in this great technical industry of engineering. Unless you establish an organisation and intelligent control worthy of the name, how are you going to deal with this problem that I have suggested, of developing our manufacture of a great many highly specialised machines that we do not make to-day? What would be the use of half a dozen firms simultaneously saying "That is right, that is good gospel; we must start and not tell the other fellow," and then proceed simultaneously to make a new machine the market for which could be satisfied by one of them? In the result all would be disgusted and would lose their money. Unless you are going to have some kind of control, consultation and agreement among yourselves as to how you are going to develop, you will get into worse difficulties. The so-called organisation of the engineering industry in this country is a disgrace. It is true that you cannot have only one organisation for engineering in this country. The industry is too complicated. There must be separate organisations, each to deal with its own affairs, in the various departments of the industry; but they should be federated so that the industry could speak with greater authority and the collective wisdom of the industry be represented. We have all been approached on this great question of national defence. Well, we do our best, but engineering has not yet got the organisation of which it is worthy and which it should have.

* The British Engineers' Association (Inc.) February Monthly Luncheon Meeting. Address by the Director.

THIS year is the centenary of the London and Greenwich Railway, which ran from Duke-street, near London Bridge, to London-street, in Greenwich. It was sanctioned in 1833 by 3 and 4 Will. IV, c. 49, and was the first railway to be authorised in the metropolitan, as the London and Birmingham was not sanctioned until later in 1833, the London and Southampton in 1834, the Great Western and the Croydon in 1835, and the Eastern Counties and London and Blackwall in 1836. In his "History of the British Railway" (1851) John Francis said: "As the first which had its commencement in London, the London and Greenwich demands notice; and in looking back upon the high hopes which accompanied its formation, on the high dividends promised, and on the excitement it occasioned, there is something akin to melancholy in the knowledge that the prospects were fallacies; that its dividends were visionary, and that its importance is now swallowed up in the South-Eastern. As a specimen of the dreams which ever accompany new undertakings it may be said that its arches were to bring in large rentals as warehouses; that pedestrians were to pay a toll; that a hundred thousand were to travel by it daily; and that three million of people who yearly visited London were to travel by it as a curiosity."

Rail and Road.

DRIVING an oil-engined car, Captain G. E. T. Eyston and Mr. A. Denby have set up a twenty-four-hour record by driving some 2293 miles at an average speed of 94·99 miles an hour. During the period of running they also set up ten other records for oil-engined motor cars.

THE annual report for 1934–35 of the Road Board records that great progress has been made in recent years with the building of by-pass roads, and the total length of these roads in Great Britain now exceeds 505 miles. Bridges have been reconstructed, widened or strengthened to meet the increased traffic loads; 62 bridges over railways and 50 over canals were dealt with in this way during the year under review, and, in addition, 57 new bridges were built on new roads, diversions, or by-passes.

THE U.S. Interstate Commerce Commission's "Accident Bulletin" for the year 1934 shows that during the period in question twelve passengers were killed in derailments, but none in collisions. The number of servants killed in derailments was fifty-seven and thirty in collisions. The number of servants killed in "movement" accidents was 4396. This good record was still further improved upon in 1935, as, according to a telegram recently received, no passengers were killed in train accidents last year.

THE trollybuses that have been running for some months between Croydon and Sutton were extended on February 9th to the Crystal Palace, completing a section of 10 miles. An interesting feature of the work is the provision of special brake power on Anerley Hill. Before descending the hill, drivers will be required to place in operation a coasting brake which will not permit the vehicle to travel more than 10 m.p.h. In an emergency, a check brake would not permit the trollybus to run backward faster than 2 m.p.h.

AT the annual meeting of the Institution of Railway Signal Engineers on the evening of Wednesday, February 12th, Mr. Walter Sydney Roberts was elected the President for 1935–36. Mr. Roberts joined the London and North-Western Railway in 1894, and in 1899 went to the Railway Signal Company, where he successively became chief draughtsman, general manager, director and general manager, and, in 1932, managing director. Besides being a prominent manufacturer of mechanical railway signalling material, Mr. Roberts is a great authority on the operation of single lines of railway.

THE census of the passengers carried on the Underground was mentioned in our Seven-day Journal of February 14th as being undertaken. That was a method used quite seventy years ago to show the number of passengers being carried by those companies whose trains ran on other companies' metals under what is known as running powers. By an agreement the running company pays the owning company a fixed sum a year to cover payment for the use of the railway and for its signalling. That does away with the necessary Railway Clearing House expenses with each ticket. The census is taken by the paying company and the result shows that the owning company gets its right proportion of the fares and that the paying company's proportion is fair. The census shows the journey covered, the class of ticket, whether by an ordinary ticket, a season ticket, or a traders' ticket.

HEREIN on January 18th last year we referred to a new type of signalling that was to be tried on the branch of the London and North-Eastern Railway between Boroughbridge and Knaresborough, a single-tracked branch, 5 miles in length, with three passing places. Each station has an "approach" signal for each direction, which takes the place of each usual distant signal, and acts as, in a sense, a 600 yards' warning of the approach of the train to a station, and for its protection whilst in the station. The approach or location boards are rectangular in shape, painted black and yellow in diagonal stripes, which are easily observed in daylight and, after dark, are illuminated by a zigzag row of hemispherical lamps, which will be picked up by powerful headlamps on the locomotive. The station signal is a larger board, painted red and white in diagonal stripes, with white reflex lenses, and three red clusters down the centre. This also will be illuminated by an approaching locomotive. On the station platform is a square board which has a flap, which, if it is permissible to proceed, is lifted and a green centre is revealed. At night a green light is displayed. The ordinary signal-boxes and signals are dispensed with.

THE Great Western annual report for 1935 shows that the railway receipts amounted to £25,738,314 and the expenditure to £20,760,662, as compared with £25,289,929 receipts and £20,350,478 expenditure in 1934. Of the principal subsidiary businesses the net receipts were, with the corresponding figures added in parenthesis:—Steamboats, £17,730 (£6066); canals, &c., £18,710 (£23,279); docks, harbours, and wharves, £46,682 (£88,893); hotels, refreshment rooms, £78,586 (£75,468). Total receipts and expenditure of the whole undertaking: Receipts, £29,786,622 (£29,280,322); expenditure, £24,817,606 (£29,280,282). Of the £25,736,314 net receipts, £10,709,704, or 41·61 per cent. (£10,569,140, or 41·79 per cent.), came from passenger traffic, and £14,794,162, or 57·48 per cent. (£14,560,385, or 57·34 per cent.), was from goods traffic. Of the £20,760,061, or 80·60 per cent., of the total receipts (£20,350,475, or 80·47 per cent.), £3,111,121, or 12·09 per cent. (£3,029,388, or 11·98 per cent.), went in the maintenance of the way and works; £3,172,184, or 12·32 per cent. (£3,135,572, or 12·49 per cent.), were for rolling stock. Locomotive running expenses, £4,054,524, and traffic expenses, £7,159,312 (£4,862,262 and £7,049,287) come under one heading and total £12,113,837, or 47·07 per cent. (£11,911,549, or 47·19 per cent.). There were 113,202,623 passengers (110,813,041) of all classes, including 85,527 third class (83,194,693) and 26,621,992 workmen (26,714,202). There were 916,937 first class (797,033), 74,189,510 third class (72,270,463), and 22,846,613 workmen (22,947,119). The average fare per passenger was: first class, 8s. 9·19d. (9s. 3·38d.); third class, 1s. 6·06d. (1s. 6·08d.); workmen, 2·89d. (2·87d.); all classes, 1s. 3·31d. (1s. 3·18d.). The tonnage was 64,755,611 (64,619,392), which produced £14,557,640 (£14,299,365), or 4s. 5·95d. average per ton (4s. 5·11d.).

Miscellanea.

AN extension to Woolwich Polytechnic, costing some £25,000, has been officially opened by Lord Snell.

IT is estimated, says the Minister of Mines, that the total production of saleable coal in Great Britain last year was 222,940,000 tons and that the average proceeds per ton of coal disposable commercially was 13s. 5½d. The quantity exported during the year was 38,714,134 tons.

DIAMOND dies for wire drawing have hitherto usually been set in steel, but an American company has discovered that the nickel-copper alloy, Monel metal, is superior for this purpose. The company reports that Monel metal "has the same shrinkage power and possesses a coefficient of expansion practically identical with that of steel, and is a better resistant to acid and alkaline corrosion than any of the common metals."

GIVING evidence before the Royal Commission on Coal Mines, Sir Alfred Faulkner said that coal mining is the most dangerous of the major industries. He said that between 1930 and 1934 the death-rate per 1000 miners was 1·16. In shipping it was 1·08; docks, 0·79; quarries, 0·76; railways, 0·46; and factories, 0·13. Notwithstanding the money which had been spent in research, the figures for mining showed no improvement over a long period.

A WELL-ATTENDED meeting of the Engineers' German Circle took place on Monday evening, February 17th, at the Institution of Mechanical Engineers, when Dr.-Ing. W. Fahrenbach, of Berlin, gave a lecture on "Modern Electric Welding Machines." The lecturer dealt particularly with resistance welding machines and described in turn spot, seam, and butt welders, both of the hand-operated and power-driven types. Interesting particulars were given in connection with projection welders and new machines designed for the welding of thin non-ferrous alloys. A good discussion took place, and afterwards an informal dinner was held at Schmidt's Restaurant, Charlotte-street.

THE term of appointment of Sir James Devonshire, M.I.E.E., who has been a member of the Central Electricity Board since its constitution in 1927, has expired, and the Minister of Transport has appointed in his place Mr. Robert Patrick Sloan, M.I.E.E. Mr. Sloan is resigning, in the course of the next three months, his membership of the boards of the Greater London and Counties Trust, and Edmundsons Electricity Corporation, Ltd., and their associated companies. Mr. Sloan is a Vice-President of the Institution of Electrical Engineers, a member of the National Consultative Committee of the Central Electricity Board, Past President of the British Electrical and Allied Industries Research Association, Past President of the Incorporated Association of Electrical Power Companies, and Past President of the British Electrical Development Association.

THE British Foundry School, which offers a training of one year's duration, of advanced character, in foundry science and practice, made a beginning in October last, and thirteen students are taking the course for the first session, now in its second term. In addition to the lectures and laboratory work, supervised by a permanent lecturer-in-charge, Mr. J. Bamford, B.Sc., special courses are given by members of the staff of the Birmingham Central Technical College in which the School is housed. Furthermore, over fifty lectures were given during the first term by specialists in various aspects of foundry work. Each week a foundry visit is made, and during the session it is hoped to arrange for a three-day visit to another foundry centre, during the last term. Students in the main have been nominated by their employers and the School authorities are now prepared to receive the names of prospective students for next session, beginning in September, 1936. A prospectus and further information may be obtained from the Secretary of the School, Central Technical College, Suffolk-street, Birmingham.

THE particulars of eighty-seven underground fires in mines during recent years have been collated by a committee of the Institution of Mining Engineers. Investigation showed that naked lights were the principal causes of fires underground. In sixty-three of the eighty-seven cases, the fires were put out quickly or within a few hours; in six cases the fires were under control within a few days, and in eighteen cases the areas affected were sealed off. With regard to the materials involved in spreading the fires, timber had accounted for thirty-eight, coal and coal dust were responsible in twenty cases, and brattice cloth in nine cases; for the remainder, there was a variety of materials. Of the thirty-eight cases in which timber was fired, wooden frames of haulage pulleys on curves and at return wheels accounted for nine, covering wood and lagging seven, timber supports sixteen, and miscellaneous six. Of the nine cases of brattice cloth set on fire, six were caused by naked lights. It was apparent that, whatever might be the initial causes of underground fires, timber, coal, coal dust, and brattice cloth provided the readiest methods of spreading them.

THE manufacture of rock wool, one of the most effectual insulation products on the market, was commenced in Canada last year. Two plants are in operation, both in Ontario, one at Thorold, and the other at Brantford. The Thorold plant is using electric furnaces and a special mechanical device for converting the molten rock into fibres, and is producing a long-fibred wool having a density of from 3 lb. to 4 lb. a cubic foot. The product made at the Brantford plant is a standard short-fibred rock wool having a density of 8 lb. to 10 lb. a cubic foot. Establishment of the rock wool industry in Canada followed investigational work in the laboratories of the Dominion Department of Mines. This work showed that large deposits of a special type of limestone, discovered by the Department in the Niagara district, in Ontario, in the course of its survey of the limestone resources of Canada, were suitable for the manufacture of the material. Rock wool is marketed in various forms and, with a binding material added, in various shapes made to the customers' specifications. It is suitable for thermal insulation for temperatures up to about 1200 deg. Fah. Certain lightweight bricks made from rock wool banded with a special cement can stand much higher temperatures.

Air and Water.

IT is reported that the United States Atlantic Transport Company 27,132-ton liner "Columbia"—formerly "Belgenland"—is being offered for sale for breaking up.

AT the beginning of this month there were sixty Norwegian vessels of 207,593 tons laid up, as compared with twenty-eight vessels of 69,480 tons on Jan. 1st, 1936.

THE Round India Air Race for the Viceroy's Cup has been won by an Indian Army officer, Lieut. Misri Chand, flying a hired D.H. "Moth." The total length of the course is 1520 miles.

TWO vessels on the Woolwich Ferry service, the "Gordon" and the "Squires," are to be lengthened from 62ft. to 72ft. to relieve the traffic congestion. The cost of the work is estimated at £8000.

THE Cunard-White Star liner "Homeric" is to be sold for breaking up. This 34,351-ton vessel was completed in 1922 by F. Schichau, of Danzig, and surrendered under the reparations agreement to this country.

THE Union Castle Mail Steamship Company's liner "Winchester Castle," bound from South Africa to Southampton, recently went ashore near Portland Bill. The vessel was refloated after three hours and is believed to be undamaged.

AN agreement has been reached in Washington regarding an experimental air service between Germany and the United States. The Lufthansa has already begun trial flights in connection with the service with the Dornier Wal flying boat.

ACCORDING to a message from Reuter, Mr. R. A. Parkhill, the Australian Commonwealth Defence Minister, is expected shortly to announce an arrangement with industrial and financial interests in Australia and overseas to establish a complete aircraft manufacturing industry in Melbourne.

DURING January there was a considerable advance in traffic at Southampton. According to the figures issued by the Southern Railway, compared with the same period last year, the number of vessels inward rose from 179 to 212, and outward from 178 to 212; imports rose from 38,156 tons to 47,710 tons, whilst exports increased from 26,593 tons to 36,162 tons.

IN calculating the estimated cost of the proposed tunnel under the Tyne between North and South Shields it will be necessary, states the *Manchester Guardian*, to add about £100,000 as compensation to be paid to the Tyne Improvement Commissioners in respect of their ferry services between the two harbour boroughs. This brings the total estimated cost of the tunnel to £1,400,000.

A NEW 15,000-ton floating dry dock, which will be stationed at Seattle, is being completed in the United States. It is being made in five sections, 90ft. long by 127ft. in width, and, departing from common practice, the dock is being built with a circular-shaped bottom instead of the usual flat bottom to enable all the water in the pontoon to be removed by the pumps.

ACCORDING to the annual summary of shipping casualties, issued by the Liverpool Underwriters' Association, dealing with vessels of 500 tons and upwards, during 1935 there were 111 vessels reported as totally lost, these comprising 100 steamers of 243,379 tons and 11 motorships of 22,084. Of the total 23 steamers of 70,159 tons and three motorships of 8027 tons were British.

THE largest vertical lift span bridge in the world has been erected at Buzzards Bay in Massachusetts to carry the New York, New Haven, and Hartford Railroad over the Cape Cod Canal. The bridge has a span of 544ft., a width of 27ft., and when open provides a clearance of 139ft. above mean sea level, with a clear canal width of 500ft. The towers at either end of the bridge are 260ft. high.

IT is announced that the Government has agreed to give financial assistance to British Airways in respect of the service it proposes to operate between London and Malmö. It has also been indicated that this company will be given a mail contract by the Post Office when the service is fully established. This is the first case in which a subsidy has been given to any British air line other than Imperial Airways.

CERTAIN changes in the regulations for the King's Cup Air Race are announced by the Royal Aero Club. The course has been lengthened from 953 miles to 1240 miles, and there will be three classes of competing machines. Last year machines were divided into two classes, according to engine power. This year there will be a third class which will include all twin and multi-engined aircraft, irrespective of power.

SPEAKING in the House of Commons, the Parliamentary Secretary to the Board of Trade recently said, in regard to the shipping subsidies, that the subsidy had justified the hopes of the Government. The decline in the rate of freight obtainable on the main tramp routes had been arrested, and an upward movement initiated. The increase in 1935 in the number and percentage of British vessels chartered compared with 1934 was especially marked.

A NEW air service between Kano in Northern Nigeria and Khartoum has been opened by Imperial Airways. This route, which is 1800 miles long, will be operated once a week in either direction and will connect British possessions in West Africa with the main services between London and Cape Town. It will be possible to fly from West Africa to London in six days by the new service. The line may later be extended to Lagos and Takoradi on the coast.

THE radio equipment which is now being fitted on the Cunard-White Star liner "Queen Mary" is the most elaborate ever fitted to a vessel. The transmitters and receivers alone weigh over 11 tons, and are controlled from a distance by a dial similar to that on an ordinary automatic telephone. In order to provide rapid radio communication between the ship and all parts of the world, the installation will operate on thirty-two different wavelengths—eleven for short wave, nine for radio-telephony, seven for long wave, and five for medium. Changing over from one wavelength to another can be done in less than five seconds.

PILE-DRIVING EQUIPMENT FOR THE KINCARDINE-ON-FORTH BRIDGE

SIR ALEXANDER GIBB AND PARTNERS, WESTMINSTER, ENGINEERS; THE CLEVELAND BRIDGE AND ENGINEERING COMPANY, LTD., DARLINGTON, CONTRACTORS

(For description see page 196.)

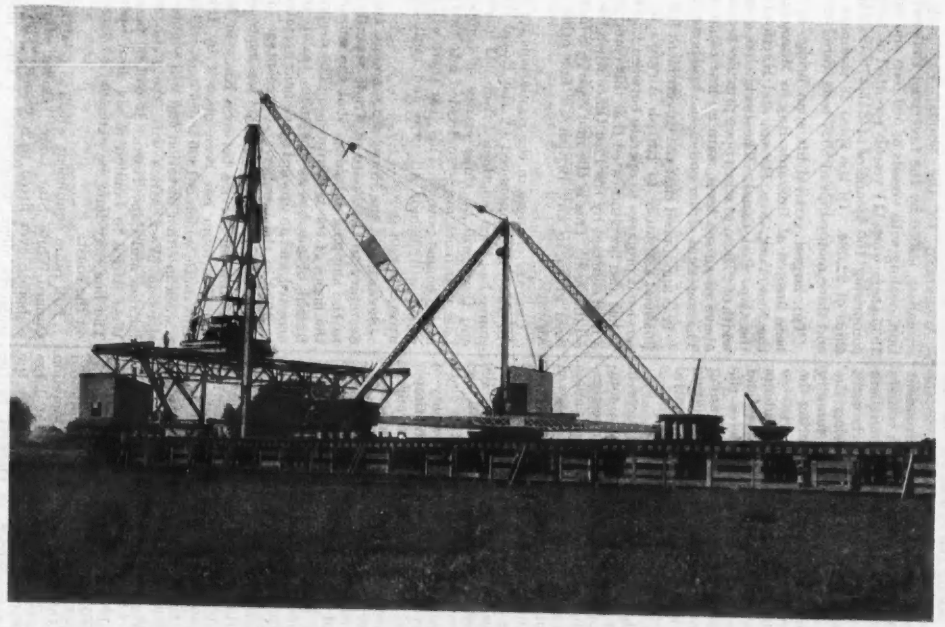


FIG. 15—DRIVING PILE AT SOUTH END OF TEMPORARY STAGING

FIG. 17—PILE-DRIVING EQUIPMENT AND TEMPORARY STAGING

FIG. 16—VIEW OF PILES FOR PILED VIADUCT

FIG. 18—PILE-DRIVING AT PIER NO. 15

The Engineer

FEBRUARY 21, 1936.

VOL. CLXI. No. 4180

Contents.

THE ENGINEER, February 21st, 1936. PAGE

A SEVEN-DAY JOURNAL ... 193
AMERICAN BEACH AND SHORE PROTECTION WORKS. No. VI. (Illus.) ... 194
THE KINCARDINE-ON-FORTH BRIDGE. No. I. (Illus.) ... 196
3300-VOLT RECTIFIER SUB-STATION EQUIPMENT. (Illus.) ... 200
MACHINERY AND THE NATION ... 202
RAIL AND ROAD ... 203
AIR AND WATER ... 203
MISCELLANEA ... 203
LEADING ARTICLES—
The Depressed Areas Again ... 205
The Long Week-end ... 205
The Southern Railway Company's Breakdown ... 206
LITERATURE ... 206
SIXTY YEARS AGO ... 206
RECENT PRACTICE IN HYDRO-ELECTRIC POWER DEVELOPMENT. No. II. (Illus.) ... 207
LETTERS TO THE EDITOR—
Mechanical Stoking for Scotch Marine Boilers ... 209
Papers and Proceedings ... 209
L. and S.W. Plymouth Terminus ... 209
The Erith Strike of 1876 ... 209
INDUSTRIAL EXPANSION IN SOUTH AFRICA ... 209
REMOVAL OF ACIDITY FROM FLUE GASES ... 210
IRON ROADS ON SAND. (Illus.) ... 210
THE WAVE-RING PIPE JOINT. (Illus.) ... 210
A LARGE HORIZONTAL BORING MACHINE. (Illus.) ... 210
SPARKING PLUGS WITH PLATINUM POINTS ... 211
A NEW PIPE BENDER. (Illus.) ... 211
AMERICAN ENGINEERING NEWS ... 211
THE BRITISH INDUSTRIES FAIR AT BIRMINGHAM. No. II. (Illus.) 212
LAUNCHES AND TRIAL TRIPS ... 214
MARKETS, NOTES AND NEWS ... 215
CURRENT PRICES FOR METALS AND FUELS ... 216
FRENCH ENGINEERING NOTES ... 217
BRITISH PATENT SPECIFICATIONS. (Illus.) ... 217
FORTHCOMING ENGAGEMENTS ... 218
PERSONAL AND BUSINESS ANNOUNCEMENTS ... 218
CONTRACTS AND ORDERS ... 218

EIGHT-PAGE SUPPLEMENT—THE BRITISH INDUSTRIES FAIR AT BIRMINGHAM.

NOTICES TO READERS.

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THE DEPRESSED AREAS AGAIN.

A SECOND report on the depressed areas in England and Wales has just been issued by Mr. Malcolm Stewart. It cannot be regarded from any point of view as encouraging, and from the engineering aspect it gives little cause to expect that anything which the Commissioner may be able to do will have a material effect upon the conditions. It is true that since his first report was made Ebbw Vale has been saved by the action of Richard Thomas and Co., Ltd., and that T. W. Ward, Ltd., have decided to open a steel works at Jarrow. Mr. Stewart describes at some length his negotiations over Ebbw Vale, his correspondence with Sir John Beynon, chairman of the company, and his commissioning of Mr. Brassert to report upon the potentialities of the works. But he admits that the course taken by Sir William Firth, chairman of Richard Thomas and Co., was an "unexpected development" and that he has not been "directly concerned in the negotiations" over the Jarrow deal. These candid admissions can only mean that the two transactions were but little affected by the great exertions he is making, but are rather a natural reaction to the rapid improvement which is taking place in the steel industry. Nevertheless, he very properly rejoices over them and notes that they "should completely change the prospects for those two towns, which were among the worst hit communities to be found in the Special Areas a year ago." He is, however, constrained to add that whilst these results are gratifying, "the effect is relatively limited. There remains the problem of many other places almost, if not quite, as depressed."

In his first report Mr. Stewart mentioned that he was circularising manufacturers outside the special areas with the object of ascertaining their objections to those areas, and the possibility of inducing them to enter them. In the present report he gives some particulars of the results secured. He regrets that the results are disappointing. He wrote to 5829 firms; 4066 did not reply at all; 1313 gave "unqualified negatives" to all questions; 386 gave "qualified negatives" to all questions; and only 64 "answered at least one question in the affirmative." There were only three principal questions. The first asked if the firm had established works in the special areas during the past few years; the second if it had considered doing so; and the last was it prepared to consider doing so now. Out of the whole lot only 35 had thought of starting works in the areas and only 12 were disposed to think of doing so now. It is common experience that the percentage of replies to questionnaires is always small, and the response Mr. Stewart secured, about 30 per cent., was on the high side. We fear, however, that silence in this case must also have meant an "unqualified negative." The effort taken as a whole for what it is worth justifies the Commissioner's opinion "that there is little prospect of the Special Areas being assisted by the spontaneous action of industrialists now located outside the areas." But he refuses to surrender all hope. He believes that the indifference is due to "vaguely felt prejudices," which, he suggests, could be overcome by taking measures to make the areas more attractive and their economic advantages better known. Whilst sympathising heartily with Mr. Stewart in the thoroughness with which he is carrying out his commission and deeply with the sufferers in the depressed areas, we find it difficult to believe that any attempt, within the limits of sane economics, to induce firms to select for their works sites which do not appeal to them are destined to fail. It must not be forgotten that the special areas are areas which once enjoyed prosperity; not new and untried areas. In some cases they are suitable for one industry and one industry alone; they grew up on that industry and died when it came to an end. Others do not suffer from that limitation, but they suffer from local defects which drove the industries away, and have never succeeded in drawing back to themselves industries which settled in more attractive localities. Consider, for example, the development of new factories on the outskirts of London. Contrast those factories in pleasant surroundings with the conditions that prevail in many a northern industrial town. What sort of counter attraction can those towns offer to draw new factories to them? The possession possibly of skilled artisans. But those artisans are skilled in a particular trade and conceivably would fail to supply the labour required for a different industry. If certain trades are excluded—shipbuilding, mining, metal working, &c.—what is there to make firms prefer the industrial north and west to other districts? We fail to see anything. We suggest it as a possibility that many of the depressed towns, having grown up with the development of factories, have accumulated in the course of a century and a half conditions which are distasteful to the modern manufacturer who seeks light and air, cleanliness and pleasant surroundings for his workpeople. If a new firm had before it the choice, with equal economy, of opening its works in an open field and in a depressed area, which would it select?

Whatever the Commissioner or the Government can do to provide new attractions in unattractive places, it is probable that the improvement of trade will be more effective than any artificial seductions. We have already seen that Ebbw Vale and Jarrow are being revived by the present and potential conditions. Other parts of the special areas may, and very sincerely we hope will, benefit in the same way. That will be spontaneous and natural recovery, economic in itself, costing the country nothing, and increasing its prosperity. On the opposite side, money may be uselessly thrown away in vain endeavours, or firms may be induced to go to places only to find in a few years that the amenities are not what they were given to expect and that the disadvantages are greater than they feared. If spontaneous revival does not take place, we fear there is but one conclusion. The depressed areas should be allowed to slip back to their native condition with as little distress as possible, whilst the inhabitants are coaxed to seek employment in other districts. We doubt gravely that any planning can save them.

The Long Week-End.

THE problem of the shorter working week which is now engaging attention in many industries may, and should, be regarded from two points of observation—either as a reduction of working days or as a lengthening of the days of leisure. This is no fanciful and artful division, but one of real importance. For, on the one hand, we have all the industrial problems and difficulties associated with the lessening of the hours of work, and on the other we have the not less important problems of the use that is made of the hours when no work need be done. If those hours are spent healthily well and good; if they are not so spent, but are given up to occupations which are injurious or are passed in an idleness which is neither rest-giving nor refreshing, then it would be better that the longer hours should be continued. It should not be forgotten, moreover, that the spending of leisure, almost in any way save that of lying in bed, costs money, and that it must therefore appear in two places in the total accounts, first, as equal money for less hours, and second, as more money, to pay for the cost of utilising the hours not spent in factory or workshop. No doubt the demand for shorter hours is largely the result of the growth of means of using them, and if it were certain that the provision of healthy forms of recreation was keeping pace with the increase of leisure, anxiety on this score would cease.

It could have been said not many months ago that the long week end was no more interesting to employers and employed than is Sunday to the natives of Hawaii. Where there was not enough work to tire men out, bodily or mentally, Sunday as a day of rest had no significance. The five-day week was then common out of necessity. With improved and improving conditions the question is taking on a different complexion, and it was therefore with no small interest that we listened recently to an after-dinner debate upon it organised by the British Chemical Plant Manufacturers' Association. The opener was Mr. B. A. Bull, production director of Boots Drug Company. In the factories and offices of that company the five-day week was introduced some months ago as the best way of passing on to the employees some of the advantages secured by organisation and mechanisation without adding to the cost of the product. The choice lay between shortening the working day and shortening the week. The company elected to do the latter for reasons which seem to us quite adequate in its case. Unfortunately, Mr. Bull had to admit that there was no sure method of estimating the economic result. The five-day week was instituted because the company's new works at Beeston had increased its output by over 50 per cent. and equivalent sales could not at once be found. Furthermore, organisation and planning were being carried on with such success and energy that they were facilitating and hastening output. All that can be said is that the wages bill rose by 2 per cent., whilst the output mounted by 52 per cent. Now it is quite obvious from these few facts that Mr. Bull was dealing with a very exceptional industry; not even the most repetitive of mass production engineering works approach it. It is to be regretted that he did not give the ratio between labour costs and total costs in Boots factories, but we are in little or no doubt that even the extraordinarily low figure of 15 per cent. attained in motor car factories is surpassed in the mass production of drugs. If that is so; the effect of shorter hours for the same pay is clearly much less than, say, in an engineering works, where the costs of labour may be in the neighbourhood of one-third of the total expenditure. In other words, the increase of 2 per cent. in the wage bill became all but insignificant in Messrs. Boots' total costs. Hence, it would be very unsafe indeed to draw any general deductions from the success of the forty-hour week in these factories. But an interesting endorsement of an argument which we have presented before arises from consideration of them. The argument is that the shorter working week will not increase employment for long, because it will oblige employers to adopt more and more rapidly means of reducing the incidence of labour costs in total costs. That ought to be an obvious fact to everyone, particularly if they have kept in mind the causes of the rise of automatic machinery in America. It progressed there because labour was scarce and wages high; here it was slow in coming because the reverse conditions obtained. The logical way to increase the amount of labour employed is to make it cheap; to increase its cost by shortening the week for the same wages is a sure way to compel employers to extend the use of labour-displacing machinery. It is probably true that they will in the majority of cases extend the use of machinery in any case, in order to accelerate output, but if they have the added reason that they will at the same time reduce total costs, they will hasten the process. We must add, to prevent a false deduction being made, that the reduction in the ratio which labour costs bear to total costs does not imply a reduction in the total quantity of labour employed. Industrial history shows that the reverse result takes place.

We have little doubt that in years to come

the long week end will be accepted by all industrial nations. But we are still a long way from it, and it cannot be said, save for equivalent factories, that the experience at Beeston has brought us appreciably nearer to it. Indeed, the evidence of several speakers in the discussion showed very clearly that for general engineering a reduction of hours is impracticable, particularly if we desire, as all wise men must, to maintain and extend our export trade. It happens, moreover, that another argument than those we have indicated may be advanced against the reduction of hours. It lies in the difficulty which employers are experiencing in their search for skilled mechanics. With a shortage of the best quality men it is necessary to employ those that are available for the full forty-seven hours and even to keep them on overtime. That is but one item in a series of objections. Mr. G. S. Whitham, who was introduced by the chairman as "from the War Office and playing a very important part in the re-equipment of our fighting forces," summed up the position neatly in these words: "The forty-hour week was a desirable condition where labour was not a significant part of the ultimate cost of the product, but where the industry was of an international character and required large numbers of skilled men it was not a feasible proposition at the present time. If we could get other countries to come down to forty-eight hours a week, he believed we could beat them if we had a forty-hour week, but until that was done this country could not compete so far as engineering was concerned."

The Southern Railway Company's Breakdown.

THE electrical breakdown on the Southern Railway of Saturday last demonstrated how, even in these days, an extensive system depending on electricity for its motive power can be disorganised. It was the worst breakdown the company has experienced since the first lines were electrified in 1909, and caused great inconvenience. Nearly all electric trains are reported to have been stopped on the Eastern and Central sections. Many steam trains were held up by electric services blocking lines and by failure of signals. Trains filled with passengers were left standing along the lines, in some cases in tunnels, without light or heat. The breakdown occurred at about 9.30 a.m., and it was not until about 11.30 that all services were restored. Even after all trains had been restarted all local services were considerably delayed. Many trains are said to have stood for as long as twenty minutes at each station, and passengers naturally suffered much discomfort. Fog greatly added to the difficulties, especially as the lighting at stations, including Waterloo, failed.

As is usual on these occasions, the information available concerning the cause of the trouble is vague. Electrical people are always ready and willing to talk about their successes, but are reluctant to speak of their misfortunes. All we have been able to learn after several applications for information is that the dislocation of the electric train services on certain sections of the suburban lines was due to the failure of several high-tension cable joints, brought about by a very heavy surge on the high-tension supply system. The cause of this surge, we understand, has not yet been established, but possibly it originated on the overhead lines, which, on the whole, have not tended to ensure the continuity of electricity supply in this country. Papers published since the establishment of the grid and the use of overhead conductors generally have shown that surges on outdoor equipment are liable to occur under unfavourable atmospheric conditions, such as those that prevailed last Saturday. The fog may or may not have been at the root of the trouble. In any case, it is pretty evident that the surge subjected the cable joints to an undue stress, which caused them to fail and to interrupt the supply over an extensive area. Although the capacity of a cable connected to an overhead line may result in a considerable reduction in the amplitude of the wave, it does not eliminate it, and the first part is subjected to the whole of the over-voltage.

With all the investigations that have been carried out on surges, the protective devices that have been devised and the care that has been exercised by the Southern Railway Company to ensure that if one circuit fails another is ready to take its place, a breakdown such as that which occurred last Saturday would seem to be wellnigh impossible. It is evident, however, that there are problems associated with electricity supply that remain to be solved, and that from the point of view of reliability electric operation cannot at present compare with steam. The breakdown provides another forcible argument against the electrification of this country's main lines, which, in spite of all that has been said to the contrary, really leave little to be desired.

Literature.

Organization and Administration of Industry. By F. T. LLOYD-DODD, M.A., D.Sc., and H. J. LYNCH, Ph.D., B.Sc., A.M.I.N.A. London: Sir Isaac Pitman and Sons. 1935. Price 15s. net.

THIS book purports to be a complete introduction to industrial science, and stress is laid on the necessity for a knowledge of that science by those engaged in technical, managerial, or administrative capacities. The authors claim that the present industrial structure is but another stage in the process of evolution that has already occupied hundreds of years. Their book is an honest effort to develop the theme on this hypothesis.

The work is divided into three clearly defined sections, of which the first is principally historical, and in it the different phases of development are carefully delineated. The rise and fall of the craft guilds are faithfully described, and their merits and defects are analysed. An interesting chapter is devoted to the industrial revolution, in which the causes leading to it are examined, and the important events that followed, up to the critical period through which the country passed after the Napoleonic wars, with their bearing on industry, are considered. The last chapter sketches the principal happenings of the succeeding century, one of phenomenal progress, but bringing with it problem upon problem, culminating in the feverish activity of the Great War, and followed by periods of unprecedented boom and depression.

In commenting on the effects of the war on production, we are surprised that no reference has been made to the great impetus to methods of mass production definitely attributable to that catastrophe. Many firms were for the first time brought to realise the value of working to predetermined limits, and to recognise the benefits accruing from an orderly application of jigs, gauges, and fixtures.

Part II sets out the general relation existing between industry and the economic world, and the resultant complications. In addition to the many economic problems considered, a good deal of attention is also bestowed on those of a social nature.

In describing the structure of modern industry, an interesting definition of rationalisation is given, as "the methods of technique and organisation designed to secure the minimum waste of either effort or material." The authors are of opinion that when the science of administration has attained maturity, "the administrative body," while safeguarding investors, will so direct industry that it best serves the interests of society, and is also most conducive to the welfare of labour. But, as they say, "that day is not yet."

The manner in which industry is financed is discussed, and the policy of British banking explored, and contrasted with the methods obtaining in other countries.

A useful chapter is devoted to combinations in industry, and the different forms of cartels, those "children of distress," are explained, and contrasted with trusts and mergers. The dangers of monopoly are not ignored, but useful means of controlling monopoly are suggested.

The fascinating, if elusive, problem of trade cycles is very fairly examined, and it is affirmed that they must be attributable to specific causes. Meteorological or climatic conditions might have been sufficient reason for those of former days, but recently various theories have been brought forward, including psychological, under consumption, over consumption, competition, and monetary causes, but probably the cycles are due to a combination of some, if not all, of these effects.

On the subject of unemployment, the authors evidence an optimistic outlook. They draw attention to the fact that the displacement of labour by new machinery and methods has existed from the time of the Industrial Revolution. Present-day "luxuries" become the necessities of to-morrow, with the result that there is a need for ever-increasing productivity. The problem then resolves itself not so much into one of finding work for unemployable people, but rather of fitting the square peg to the round hole, a problem not beyond the wit of man to solve. Closely allied with this is the subject of education, and we are cordially in agreement with the condemnation of "blind alley" occupations for boys. They should always be trained with a better post in view. Other labour problems, including the fallacy of "ca'canny," and the possibilities of works committees, &c., are dealt with in a suggestive manner.

Part III describes the general principles of administration, involving management in its varied spheres, production, and its ancillary functions, while such important subjects as factory location, and the planning of modern works receive attention. Even the different systems of payment are introduced, and a very interesting chapter is devoted to industrial education, and a helpful comparison of the methods employed in Germany, Russia, and other countries is given.

From the foregoing it will be admitted that the field covered in this section is very wide, and it is hoped that it will not be regarded as ungenerous if allusion is made to notable omissions, but we feel that perhaps the distribution of the space allowed to different subjects might be modified. It has justly been said that the success or failure of a modern enterprise is largely dependent on good cost accounting, coupled with efficient estimating, yet the former is hurriedly despatched in a few short paragraphs, and the latter is conspicuous by its absence.

It would be possible to criticise a number of the conclusions reached, but we must content ourselves with a few remarks. A suggestion is made that "to replace completely an established departmental system would mean so vast a change that the difficulties met with would be almost unsurmountable." We are of opinion that if the change to functional organisation appears warranted it is better to face the temporary difficulty rather than adopt a compromise. It has been successfully accomplished in unpromising circumstances.

We do not agree that part of the function of the progress department should be the maintenance of works discipline, being convinced that this is the concern of the shop foreman.

While there is truth in the assertion that in cost accountancy "even with the most meticulous care . . . results will always be approximate," this should not be taken as a reason for being content with a crude method, for with a properly conceived system the results may be so good that we can legitimately speak of "actual costs" without even a twinge of conscience.

An interesting, instructive, and suggestive volume closes with a useful bibliography, in which the names of a number of other standard works might have been included.

SIXTY YEARS AGO.

IN the years which followed 1872 the trade union movement in this country greatly extended its power and the scope of its activities. Organised at first as provident or benefit societies for the sick and aged the unions subsequently took in hand the regulation of wages and conditions of work. In the early 'seventies they began to employ their power in the political field. That power was great. In 1875 one union alone, the Amalgamated Society of Engineers, had at its disposal a fund of £260,000 contributed by its members primarily for benefit purposes but actually in the hands of the leaders for employment in any direction they cared to choose. The growing might of the unions and their clearly expressed intention to extend their activities still further induced among the employers a movement for federation. In 1875 the National Federation of Employers of Labour was formed and in 1876 the British Iron Trade Association came into being. In our issue of February 25th 1876 we reported the proceedings at the first meeting of the second-named body. Mr. G. T. Clark of the Dowlais Iron Company occupied the chair. In his opening address he looked back, regretfully it would seem, to the days, then not so far distant, when the iron trade of the country was in the hands of individuals or of private companies with a small number of partners. The ironmaster of those times, he said, confined his attention to the manufacture and sale of his metal. There was little legislative interference with his business and the relationship between labour and capital troubled him not at all. His point of view might be narrow yet he belonged to a remarkable race of men, mostly self-made, strong, firm, obstinate, very self-reliant, rough but not unpopular with their workpeople, possessing great kindness of disposition and the great gift of managing men. Such were Sir John Guest, the Crawshays and the Hills in Wales, the Knights and Darbys in Staffordshire and the Bairds in Scotland. Within a generation men, circumstances and conditions changed, largely as a result of the introduction of joint-stock companies. The old element of personal responsibility disappeared and simultaneously immense discontent arose among the workpeople who believed—and in Mr. Clark's opinion their belief was not wholly ill-founded—that they were being deprived of their fair share of the returns which their industry had helped to create. In the effort to raise wages the unions adopted all means to diminish production. They restricted the number of apprentices, shortened the hours of work, discouraged piecework, and where possible sought to prevent the employment of machinery. Their will in these matters was enforced by methods of coercion extending from social exclusion up to serious bodily injury and even death. At the dictates of committees whose deliberations were usually secret all individual liberty, Mr. Clark stated, was being forbidden. In these circumstances the British Iron Trade Association was established in 1876 to form an authority for united action upon the part of the employers. On the very first day of the new body's existence, following the Chairman's address, a motion was brought forward commending as a means of settling disputes boards of arbitration and conciliation such as those which already existed in the North of England iron manufacturing districts. . . . The Association no longer exists but the spirit in favour of conciliation and arbitration which it manifested on its first day marked practically the whole of its life and as a result the iron and steel industry of this country has had an enviable record of freedom from strikes and industrial troubles.

DURING 1935 the amount of gas produced in Great Britain was 332,169 million cubic feet, an increase of 5421 million cubic feet over the production of 1934.

Recent Practice in Hydro-Electric Power Development.*

By B. HELLSTROM, M. Inst. C.E.

No. II.

(*Continued from page 182, February 14th.*)

E.—COMBINATION OF WATER POWER AND STEAM POWER.

So far we have dealt with available water power only.

If, in the example quoted, primary power only, namely, power available every day of any year, had to be generated, the maximum output would be limited to 14,000 kW (point N)—Fig. 5A, or, at the most, 15,500 kW (point R). In the latter case, however, a reduction of load of 1500 kW would have had to be made for a few days during the highest flood. Such utilisation of the water power station would

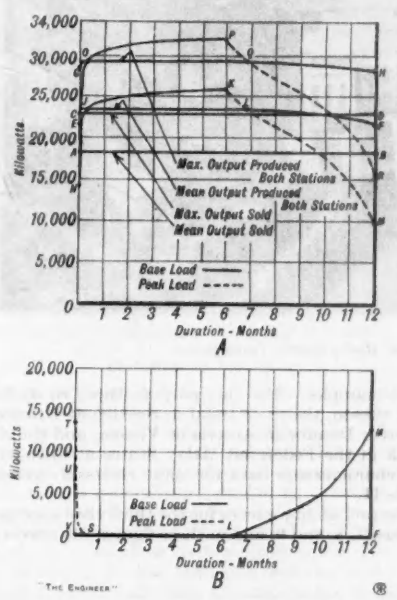


FIG. 5—*A, Power Available at Chenderoh and Output at Consumer Terminus; B, Power Required from the Steam Station.*

not have been an economic proposition. As already mentioned, a steam power station was erected for reasons which will be referred to later. An estimate of the capacity and the output required of the steam station can be made by duration curves. After some calculation it was found that the mean output of primary power to be sold at the consumer's terminals would be slightly more than 18,000 kW, equivalent to the sale of 160 million kWh per annum. This is represented on the diagram by the straight line A B.

The maximum output sold, corresponding to a

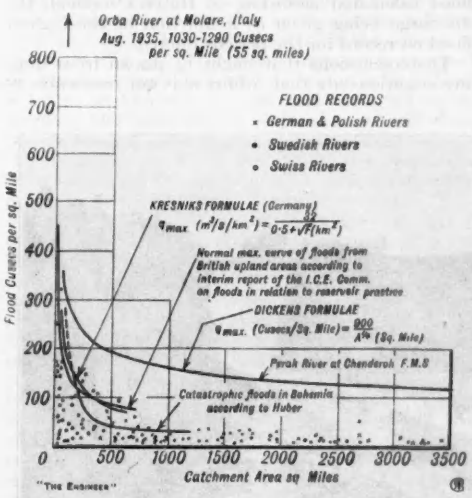

Orba River at Molare, Italy
Aug. 1935, 1030-1290 Cusecs per sq. Mile (55 sq. miles)
FLOOD RECORDS
German & Polish Rivers
Swedish Rivers
Swiss Rivers
KREBNIKS FORMULAE (Germany)
Normal max. curve of floods from British upland areas according to interim report of the I.C.E. Comm. on floods in relation to reservoir practice
DICKENS FORMULAE
Perak River at Chenderoh F.M.S
Catastrophic floods in Bohemia according to Huber
Flood Cusecs per sq. Mile
Catchment Area sq. Miles
"THE ENGINEER"

FIG. 6—*Flood Records.*

load factor of 0·80, is shown by the straight line C D. Taking losses in generation and transmission into account, the mean output that has to be produced on the turbine shafts in both stations to meet the mean output to be sold is represented by the curve E J L F. The corresponding maximum output that has to be produced in both stations is shown by G O Q H.

By comparing the curve G O Q H, representing the power required, with the curve N O P Q R, giving the water power available at the water power station, it will be seen that the power requirements cannot be fully met by water power, either in times of high flood (N O) or during periods of low water (Q R). During these periods to obtain primary power the water power from Chenderoh has to be supplemented by steam power from Malim Nawar. On the other hand, during certain periods of the year the power available at Chenderoh, which is represented by the curves J K L (mean power) and O P Q (maximum power), is in excess of the actual requirements, which, during the same period, are represented by the lines J L for the mean output and O Q for the maximum output.

It should be noted that during low water the hydro-electric station is used for supplying peak loads, and

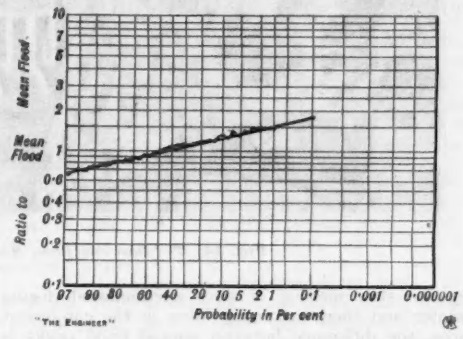


FIG. 7—*Probability Diagram for the Indal River at Krangede, 1882–1929.*

the steam station is run as a base-load station. At high water the conditions are reversed. This is because the steam station at low water can then be run with high efficiency at a constant daily or weekly load for the greater part of the time, the daily variations being met at Chenderoh by utilising the pondage above the dam. On the other hand, at high water the water turbines have to be run at full gate opening, and the daily variations are taken up by varying the load at the steam station. In Fig. 5A and 5B the base-load service has been shown by continuous curves, and the peak load service by dotted curves. The service at Malim Nawar is shown in Fig. 5B, where the curve L M represents the base load required during low water periods, and S T the maximum output and S U the mean output during high water periods.

The distance F M, which is of the same length as H R corresponds to an output of the steam station of 12,500 kW and V T (or N G) to 13,500 kW. The two points M and T represent the maximum output required at the steam station. To meet these requirements, the steam station was given an effective capa-

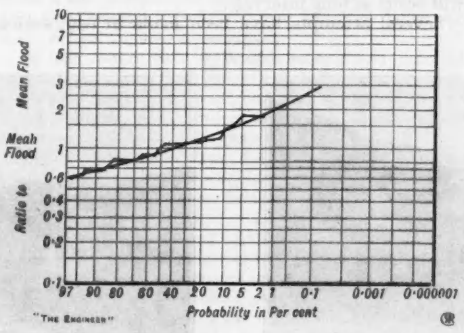


FIG. 8—*Probability Diagram for the Danube at Vienna, 1897–1930.*

city of 12,000 kW by installing three sets of 6000 kW each, one set mainly being used as a standby.

It will be seen that many of the fundamental data for any scheme, such as water power available, power to be sold, maximum steam power required for supplementing the water power, secondary power available, &c., can be worked out in a very simple way from duration curves.

As the Perak scheme can be regarded as a typical example of an interconnection between a hydro-electric station and a steam station, the main features of the co-operation may be given :—

(*a*) During low water periods in the Perak River the steam station is run, when required, at practically constant load, which gives the best efficiency, until it can be shut down altogether. Load variations are taken by the water power plant, the reservoir above the dam at Chenderoh giving sufficient pondage to meet daily and weekly fluctuations. In addition, the storage at Chenderoh assists in maintaining the full power output of the system by a certain draw-off during extreme droughts.

(*b*) During high water in the Perak River the head, and consequently the output, at Chenderoh are reduced. The water power station then supplies maximum available output with the installed capacity, and the peaks are taken by the steam station.

The steam station has also the following two duties to perform :—

(*c*) It acts as a standby for the machinery at Chenderoh and the transmission lines, and is also utilised for power factor correction and voltage regulation on the main transmission lines.

(*d*) For a gradual building up of the demand the steam station was erected in the early stages of the works, and was in operation as an independent plant for eighteen months before the hydro-electric station was put into service.

If the time unit used in the hydrograph, and consequently in the construction of the duration curve, is twenty-four hours, and no appreciable variation of flow can be expected over twenty-four hours, there is only one limitation to the use of the duration curve method which should be kept in mind. This is that the duration curve as described covers only the period of the records used for its computation. If this period is of a length of, say, ten to twenty years, most likely it will not include exceptionally high floods and extreme droughts. A special investigation of such conditions will therefore be necessary.

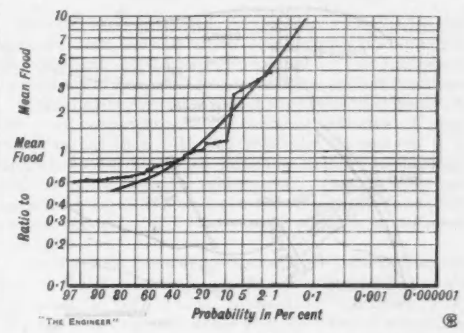


FIG. 9—*Probability Diagram for the Perak River at Chenderoh, 1897–1931.*

F.—FLOODS.

The determination of the magnitude of the maximum flood that may be expected to occur in a river is of great importance in many problems connected with the lay-out and design of a power station. The problem is complex, as floods are produced by combinations of a large number of conditions, many of which are themselves variable quantities. The final determination of the maximum flood should be based on data for the river in question, and compared with records from other rivers, preferably in the neighbourhood, where records over long periods are available.

When no readings are available, data to be obtained are generally flood marks and statements of exceptionally high flood levels by the local inhabitants.

Important factors determining the maximum

FIG. 10—*Plan of Arapuni Hydro-Electric Power Development*

flood are rainfall, size, shape, slope, and other characteristics of the catchment area, storage capacity in lakes and reservoirs, snow and temperature conditions, formation of ice dams and other temporary obstructions in the river, &c. Many formulæ have been worked out for estimating the maximum flood, but they are of value only if they have been proved by actual experience from neighbouring rivers to give more or less accurate results. It would take us too far to consider these different formulæ or run-off curves in use in various parts of the world. To give an idea of the varying magnitude of floods, a limited number of records and formulæ have been shown in Fig. 6. The records plotted (with one exception) refer to European countries, and the curves show the estimated maximum discharge for rivers in Bohemia, Germany, and Great Britain. It has been possible to make an estimate of an exceptionally high flood in the Orba River, Italy, which occurred on August

* Lectures delivered at the University of London on November 6th, 8th, 11th, and 14th, 1935.

13th, 1935, at Molare hydro-electric development.† The maximum flood discharge was found to be between 56,000 and 70,000 cusecs, corresponding to a run-off of 1030 and 1290 cusecs per square mile respectively, the catchment area being 55 square miles. The flood was discharged by twelve syphons

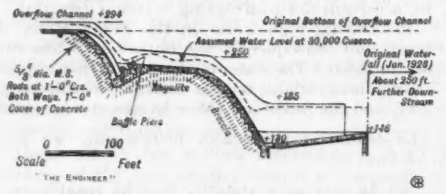


FIG. 11—*Longitudinal Profile of Protective Works at the Falls, Arapuni Hydro-Electric Power Development.*

with a total capacity of 17,500 cusecs, a spillway discharging about 5000 cusecs and two bottom outlets of 7000 cusecs. The water level rose 6·5ft. above the crest of the dams, one of which burst. The flood destroyed the power house and caused the death of 111 people. The precipitation

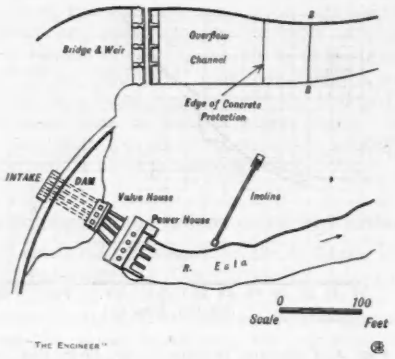


FIG. 12—*Plan of Esla Hydro-Electric Development.*

was estimated at no less than 12in. in six hours, a figure which hardly could have been anticipated. One of the drawbacks of syphons is that they do not increase their discharging capacity when the water level rises above the dam. If ordinary gate openings had been used instead of syphons, the water might

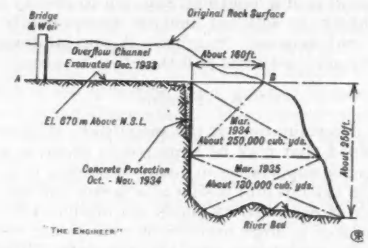


FIG. 13—*Longitudinal Profile of Overflow Channel at Esla Hydro-Electric Development.*

not have overtopped the dam and the catastrophe might not have happened.

The curve for Great Britain is taken from the "Interim Report of the Committee on Floods in Relation to Reservoir Practice," issued by the Institution of Civil Engineers, and lies close to Kresnik's formula for German rivers.

In India several formulæ are in use, and Dicken's curve is drawn for a coefficient of 900. The highest flood recorded (1926) in the Perak River since 1897 is plotted, and it will be seen that this value agrees fairly well with Dicken's formulæ for a coefficient of 900. The plotted curve can, however, by no means be taken as giving the highest possible flood.

† *Wasser- und Energiewirtschaft, Schweizerische Monatsschrift*, July–August, 1935, and *Wasserkraft und Wasserwirtschaft*, October 2nd, 1935, München.

G.—FLOOD PROBABILITY.

Naturally, flood conditions vary to a very great extent in different rivers. When the floods are caused by the slow melting of snow accumulated during winter and there are many lakes in the catchment area, the difference between annual flood peaks is comparatively small. A bigger difference between the annual peaks is found in catchment areas with little snow and few lakes; and in tropical countries with abundant precipitation and sudden, heavy cloud bursts the annual peaks vary considerably.

It is of importance to take these factors into consideration, particularly as in general the period of actual records is limited, and it is necessary to estimate, from such records compared with records from neighbouring rivers, the magnitude of the largest floods which may be expected and which certainly will occur at long intervals.

Several attempts have been made in engineering literature to estimate the high water discharge according to the law of probability. The result of such an investigation will show that the maximum discharge will be greater the longer the period for which the estimate is made. Although it must be clearly understood that the value of any method of probability in itself is rather limited, it will nevertheless give some idea of the maximum flood that might have to be provided for. There are several methods of probability used, but whatever method is employed it is necessary to base the calculations on actual records for long periods, and it is generally accepted that the period of record must not be less than thirty to forty years, if the results obtained are to be considered of any real value. The application of such calculations can most easily be explained by quoting some examples. For this purpose three rivers have been chosen, the river Indal in Sweden at Krangede, the river Danube in Austria at Vienna, and the river Perak in the Federated Malay States at Chenderoh. The characteristic data for these rivers are given in Table II.

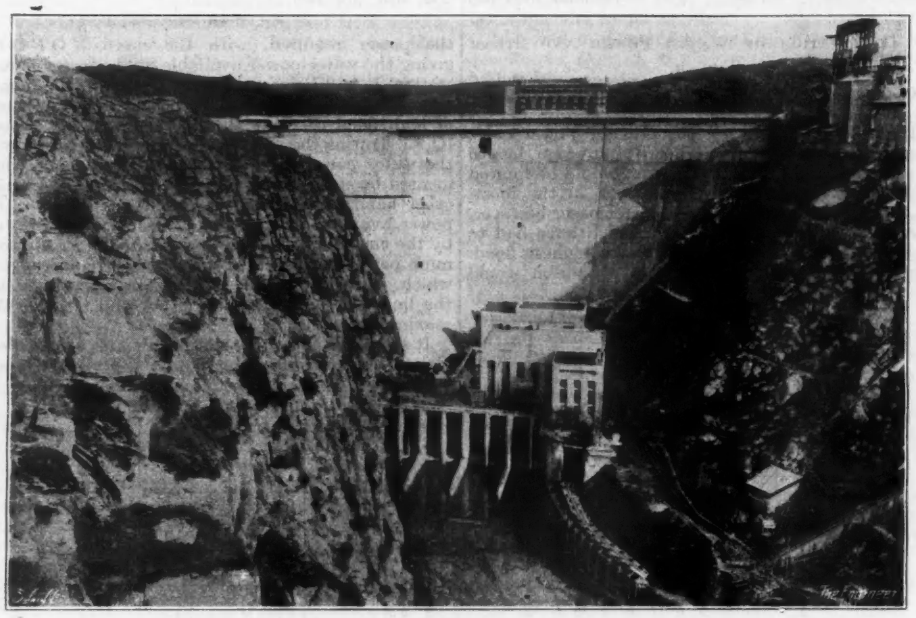


FIG. 14—*The Dam and Power-House, Esla Hydro-Electric Development.*

TABLE II.

River.	Catchment area in square miles.	Period of records.	Observed discharge during the period of records.		
			Maximum flood in cusecs.	Mean flood in cusecs.	Minimum flood in cusecs.
The river Indal at Krangede (snow-bound catchment area and many lakes)	7,000	1882–1929	70,000	46,000	29,000
The river Danube at Vienna (limited snow storage and no lakes)	39,000	1897–1930	370,000	200,000	115,000
The river Perak at Chenderoh (tropical river, no lakes) ..	2,340	1897–1931	300,000	75,000	38,000

The probability curves for the three rivers are given in Figs. 7, 8, and 9, and in these figures the maximum flood is given in ratio to the mean flood. The different trend of the curves should be noted.

Table III shows the probability of the maximum flood calculated according to Hazen's method, the discharge being given as a function of the highest flood on record for the periods quoted.

The conclusions that might be drawn from these investigations are that, whilst it is not reasonable to expect a flood in the Indal River, which is, say, 25 per cent. higher than the highest flood on record, the corresponding figure for the Danube might be taken as 50 per cent. The highest flood in the Danube that can be conveniently discharged at Vienna is less than 1·25 times the highest flood on record.

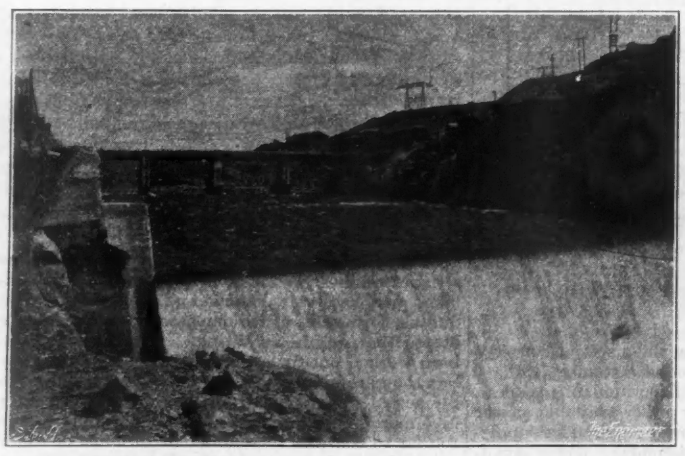


FIG. 15—*Overflow Channel and Concrete Protection, Esla Hydro-Electric Development.*

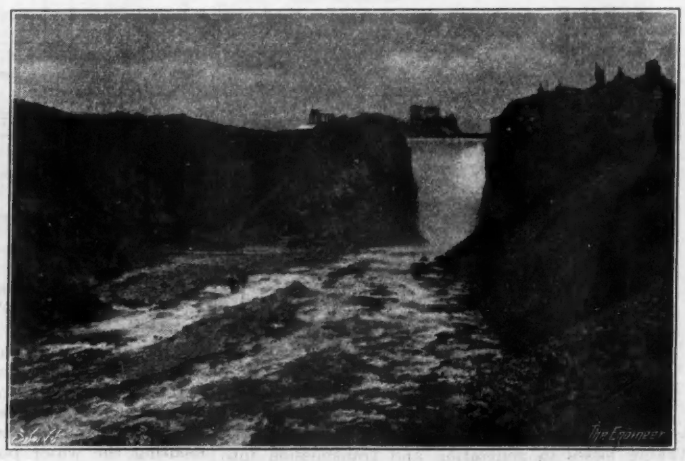


FIG. 16—*Upstream View of Overflow Channel, Esla Hydro-Electric Development.*

With a greater flow an inundation of the lower parts of the city of Vienna will occur over a large area on the left bank of the river. As the probability of such a flood is 1 : 265, it cannot be considered as being altogether out of the question.

TABLE III.

Discharge in ratio to the highest flood on record.	Probability in ratio for		
	Indal River.	The Danube.	Perak River.
1·0	1 : 100	1 : 60	1 : 55
1·25	1 : 2,000	1 : 265	1 : 90
1·5	(1 : 100,000)	1 : 1,250	1 : 155
2·0	—	(1 : 10,000)	1 : 315
2·5	—	—	1 : 550

The highest flood on record in the Perak River is 300,000 cusecs. When this flood occurred in 1926 considerable parts of the whole of Malaya were inundated. Houses were swept away, roads were flooded, and the railway service was suspended. Nevertheless, one cannot deny that a 50 per cent. greater flood might be experienced, and even a flood twice as big as the biggest on record cannot be considered impossible. In this connection it might be of interest to mention that the dam at Chenderoh was designed for a discharging capacity of 470,000 cusecs, *i.e.*, a little over 50 per cent. more than the highest flood on record, and that protective measures were recommended, so that no major disaster should happen even if a flood of 600,000 cusecs should occur.

Just as in the case of floods, the probability of extremely low water discharge can be estimated.

When considering the output of a scheme, even if planned for a sale of primary power only, temporarily reduced output at extremely high floods or extreme droughts of rare occurrence are generally left out of consideration for economic reasons. The dam and the water power station must, however, be planned so that no disaster can happen even during extremely high floods. The importance of making a conservative and careful estimate of the highest possible discharge and water level cannot be too highly stressed.

H.—Flood Erosion.

When provision is made to discharge large quantities of water it is, of course, necessary to take precautions to avoid erosion and destruction. The toe of the dam and the river bed immediately downstream of the dam are perhaps the most vulnerable points. It is generally impossible to calculate very accurately the effect of the flow and the movement of the water below a dam during flood, and this, as a rule, must be found out by laboratory tests. It would take us too far to deal with this problem, and I will confine myself to stressing the importance of careful consideration of this question and the usefulness of tests on models.

As there will be no time during the following lectures to deal with constructional measures concerning floods, I shall, in this connection, refer to a particular flood problem.

Sometimes it happens that the topography of the river in the neighbourhood of a power plant is such that floods may most suitably be discharged through a by-pass channel or a valley at the side of the main dam. If the geological conditions of such a by-pass are not thoroughly investigated and the necessary measures taken to prevent erosion, serious damage may occur. Two examples of this may be quoted.

As a first example, we will consider a catastrophe that happened at Arapuni hydro-electric scheme, New Zealand.‡ The main lay-out of the scheme is shown in Fig. 10. The river Waikato is dammed by a high concrete dam, and the water to be utilised is led to an intake by a head race about 4000ft. in length. The head race is situated in an old river bed on the left bank of the river, some 200ft. above the present river. At the end of the head race there is an intake for the pipe line tunnels leading to the power-house in the gorge. The head utilised is 175ft. and the power station has an ultimate capacity of 200,000 h.p. As the dimensions of the old river channel were ample, arrangements were made to discharge the floods through the head race over a spillway situated close to the intake, and from the spillway back to the old river bed through an overflow channel. This channel would carry the water some 1500ft. downstream of the spillway to the point on the plan marked as "Original position of water fall, 1st January, 1928," whence the water would flow down from the rocky falls into the sandy flat of Waiteti. In 1928, three months after the water passed over the spillway for the first time, a fall of cliff took place at the falls; moreover, the water eroded a channel for ¾ mile extending from the falls to the junction with the river. The first day that the water ran over the flat, where the vegetation had been cut and cleared for a considerable width, erosion began, 3 million cubic yards were shifted, which, by the next day, had increased to 5 million cubic yards, and before approximate stability was attained a day or so later, the water had shifted approximately 7 million cubic yards. In March, 1928, the crest of the falls suddenly receded 100ft., the sides of the cañyon so formed being almost parallel and vertical. Subsequently, there was no appreciable retrogression for some time, the effects of the falling water and the pool at the bottom being to widen the cañyon until its sides were approximately normal to the line of flow. This resulted in the removal of the supports of an arch, of which the columns in the vitric tuff formed the voussoirs, and a further fall of the crest took place. For a long time the subsequent falls were of moderate dimensions, until in August, 1929, a retrogression of 200ft. of the crest of the falls occurred. This fall of rock did not extend to the full height of the falls, but was confined to less than half the height. The water then flowed in a rapid for 200ft. and then fell some 60ft. into a lower pool. The position of the waterfall in June, 1930, is also shown on the plan. The remedial measures carried out at the falls are shown in principle in Fig. 11. The cost of these works was estimated at £175,000.

The second example refers to a water power station on the river Esla, a tributary of the Duero River in Spain. A reservoir of a capacity of about 42,000 million cubic feet is formed by damming the river by a gravity arch dam of concrete, the maximum height of which is 325ft. The power station is situated immediately below the dam and is equipped with four units of a total capacity of 150,000 kW. The head varies between 180ft. and 300ft. Flood water is discharged by an overflow channel blasted in somewhat decomposed rock on the left bank of the river, close to the left abutment of the dam, as shown in the plan—Fig. 12. The excavation ends at B-B, from where there is a steep slope. The width of the channel varies between 325ft. at the upstream and 200ft. at the downstream end, and the maximum discharge is estimated at 175,000 cusecs. A sketch giving an approximate longitudinal profile of the channel is shown in Fig. 13. The excavation was finished in December, 1933, and the bottom of the channel, as excavated, is marked by the line A-B. In March, 1394, a fall of cliff took place, removing about 250,000 cubic yards of rock, and the overfall receded about 160ft. The remedial measures then taken consisted of a concrete protection of the edge of the cliff, carried out in October-November, 1934, as shown in Fig. 13. In March, 1935, another fall occurred by which about 130,000 cubic yards of rock were removed by the falling water. Photographs of the overflow channel are shown in Figs. 15 and 16.

Apart from other considerations, occurrences such as those just described might lead to a more or less temporary damming of the river and an unexpectedly high-water level at the power station.

(To be continued.)

‡ F. W. Furkert, "Remedial Measures on the Arapuni Hydro-electric Scheme of Power Development on the Waikato River, New Zealand," Paper 4962, read before the Institution of Civil Engineers, session 1934–35.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

MECHANICAL STOKING FOR SCOTCH MARINE BOILERS.

SIR,—In your article on the above in tne issue for the 7th inst., it is stated that the installation of mechanical stokers on the "Manchester Port" is, you believe, the first on Scotch marine boilers afloat.

Your correspondent is in error with regard to this. As far back as 1884 my firm fitted up the Scotch marine boilers on the s.s. "State of Nevada" with sprinkling stokers, and hand-rocked fire-bars. This ship was one of 1200 tons, trading between Glasgow and New York, and made several voyages so equipped.

At that distant date stokeholds were a very different proposition to what they are to-day, being very cramped, the boilers having very small furnaces, no electric current being available, and, further, the matter of making up water for the boilers was a great difficulty.

The stokers themselves functioned perfectly, but the use of steam for the auxiliary engine for driving the stokers was prohibitive, so further use of the stokers was abandoned.

Ten years later we fitted up the s.s. "City of Chicago," a passenger liner trading between Liverpool and New York. All the thirty furnaces on the Scotch-type boilers were equipped with our coking stokers, which ran successfully for six months during the winter season. When the Shipping Company wished to place an order for us to equip their two largest passenger boats the opposition of the trade union was strong enough to prevent anything being done. This firm carried the mails, and had a subsidy from the Government for this work, so they could not risk any labour troubles; consequently, further stokers on the Atlantic service could not be applied.

In 1906 we fitted up a Scotch boiler on the s.s. "Britannia," trading between Glasgow and Bombay, which made several successful voyages.

In 1908 we fitted up a large tug, H.M.T. "Prudent," for the British Admiralty, to which we also applied our coking type stoker on a three-furnace Scotch marine boiler, and added an induced draught fan. These worked very successfully, with the result that stokers were applied to the Belleville boilers on H.M.S. "Sharpshooter," which were also successful; but when it came to the question of fitting mechanical stokers to a large battleship, the extra weight entailed was so considerable in view of the fact that everything was being lightened to allow of increased armour plating and armament, that they could not consider stokers on account of the reduced cruising area that would have been entailed.

In 1909, the celebrated American yacht, s.y. "Corsair," was equipped on her twelve Scotch boiler furnaces, giving most excellent results.

We also fitted stokers to the s.s. "Alexandra," 7000-ton cargo boat, and one or two smaller steamers; but in each case the labour opposition amounting to sabotage in some cases prevented our going any further, since which time we have devoted ourselves entirely to stokers for land installations.

As the pioneers of this class of boiler firing, we experienced the force of conservatism and opposition to the fullest extent.

Now that the stokeholds have ample room, the boilers having larger furnaces with plenty of electric current available, and labour troubles not likely to arise, there is no reason why installations on Scotch marine boilers should present any greater difficulty than many land installations.

JAMES HODGKINSON (SALFORD), LTD.,
ARNOLD HODGKINSON,
Pendleton, February 17th. Director.

PAPERS AND PROCEEDINGS.

SIR,—I was interested in reading your leader for January 24th, 1936, in which you advocate a lowering of the standards of the papers accepted by the Institution of Mechanical Engineers for presentation at their meetings.

While I agree, as you say, that the majority of engineers are more concerned with the practical utilisation of principles rather than with the principles themselves, it is difficult to see how such principles can be intelligently applied unless these are understood. I take it what you are advocating is that engineers should rely more and more on handbooks. Of what value, then, is a technical education?

Extensive experience in practical work both in England and in U.S.A. convinces me that your suggestion would represent, if carried out, a decidedly backward step. There is plenty of space in the voluminous trade magazines for articles of the type you have in mind, so why increase this?

I would hazard a guess that those particular British concerns which are leading the way in their particular fields are doing so because they have appreciated the value in the application, not of less science, but of more science to the solution of their technical problems, and I do not believe these particular companies could agree with you. As far as I am concerned, I hope that the Institution will resist any movement towards popularisation of engineering papers, but will maintain the present high standard of technical papers, and even raise it. Membership of the Institution is prized by all, so let us keep it so.

Swarthmore, Penna., J. M. LESSELLS.
February 7th.

L. AND S.W. PLYMOUTH TERMINUS.

SIR,—In your last week's issue, under the heading "Sixty Years Ago," you refer to a strike by the masons employed in building the new L. and S.W. terminus in this town, and say that you could not discover if the station was built in stone, iron, or wood.

This terminus must be the one at Devonport (not Plymouth in those days). It is almost entirely of stone, though some timber additions were made in 1890, when it ceased to be a terminus on the opening of the new line to Lydford *viâ* Bere Alston. It was opened in May, 1876, and was then one of the finest railway stations of its kind on the L. and S.W.R., if not in the whole country.

A timber erection was then being built in Plymouth for the use of the L. and S.W.R. Company and the South Devon Company, near the North-road. It was opened in 1877 and is about to be entirely rebuilt, as it is in a very decrepit state. Apparently there has been some confusion between these two stations. The latter one, of course, was not a terminus. HENRY SHAPCOTE.

Plymouth, February 13th.

THE ERITH STRIKE OF 1876.

SIR,—Your "recollections" of sixty years ago are always interesting, but the one in the current issue, recalling the piecework strike at Erith, is of special interest, as at the time I was an apprentice.

We were duly picketed, but, of course, in vain.

I learnt a good deal from the comments both of those on strike and of those in other departments of the works, which was of much value later on when a works manager.

Kenley, February 13th. APPRENTICE.

INDUSTRIAL EXPANSION IN SOUTH AFRICA.

ACCORDING to a recent report issued by the Department of Census and Statistics, established industries in the Union increased in number from 3998 in 1915–16 to 7669 in 1932–33; the capital invested advanced from £27,552,000 to £68,753,000; the number of Europeans employed from 39,524 to 87,173, and the total number of employees from 101,178 to 192,483. European wages payments rose from £6,740,000 annually to £16,823,000, and the total wages payments from £8,913,000 to £21,875,000, while the total value of the output progressed from £40,435,000 to £90,948,000. The peak year of industrial production was 1928–29, when the total value

of the output was £113,181,000. Compared with the peak year there was thus a decline of approximately £22,200,000, but it should be remembered that 1933 was the concluding year of a period of acute depression. Since 1933 all the principal industries have returned to full output, and industries generally have increased rapidly as a result of the impetus given by the extraordinary prosperity and continued expansion of the gold-mining industry. From 1932 up to the present, the mines have taken on about 20,000 more employees, while increasing the outputs of existing mines and equipping new mines, which are coming into production, has led to a great increase in the number of persons employed in engineering works, foundries, &c. Among the most important new undertakings is the Pretoria Iron and Steel Works at Pretoria, which started in the latter part of 1934, but only came into full production in the first half of 1935. This works now employs 2500 men, and the large extensions about to be made to the plant should call for a considerable augmentation of the labour force. New undertakings are being established in numbers, and the demand for workmen has so grown that, with the large numbers employed by Government on irrigation schemes, the figures of unemployment have been reduced to not much over a third of what they were a year or so ago, and a large proportion of these belong to the unemployable class. Among the many new industries which are being started are factories for the manufacture of agricultural implements, cyanide, petrol and other oils, motor car assembling, and the mining of manganese ore, which ceased during the depression, has resumed, and on a larger scale, another company being now engaged in opening up new deposits. The building boom has rendered it necessary to erect new cement works to meet the demand, and has enormously stimulated the call for structural steel. The huge increase in imports and exports, the total tonnage landed and shipped in 1933–34 was 7,420,479 tons, as against 5,745,282 tons in the previous year, has caused a large increase in the number of ships arriving and departing, and during the latter part of 1935 the fear of war in Europe has led to twenty steamship companies who had hitherto used the Mediterranean deciding to send their vessels *viâ* the Cape, with the result that apart from the extra demand for stores, bunker coal, and oil, the engineering works at the ports have been almost as busy as those situated on the Rand. Everything points to a continuation of activity in all industrial enterprises, and the numerous new works, projected and under consideration, points to the fact that industrialists are convinced that a continued expansion of demand can be counted upon.

Removal of Acidity from Flue Gases.

By ARTHUR BRIGGS, A.M.I. Chem. E., and
D. NORTHALL-LAURIE, F.I.C., M.I. Chem. E.

HITHERTO there has been no dry process in commercial operation for the removal of acidity from flue gases, although recently a method dependent upon the injection of lime in powder form direct to the flue gases at a certain temperature has been the subject of a patent. The efficacy of such a method of removing sulphur gases has yet to be demonstrated in practice.

The authors of this note have been engaged for some time in carrying out a considerable amount of experimental work on the problem of removing acidity in flue gases. After tests had been made on a laboratory scale, the trials were continued under full load conditions with boilers of the Stirling type, giving steam flows up to 120,000 lb. per hour in one or other of the power stations belonging to the Yorkshire Electric Power Company. The analytical method for the determination of sulphur in coal suggested that it might be worth while discovering to what extent the reduction of acidity in flue gas could be effected by adding lime to the coal before combustion under a boiler. A series of experiments on these lines was carried out from 1930 onwards, and a curve showing the reduction of acidity by this means was plotted against the percentage of lime used in the fuel. It was found that from three to five times the theoretical amount of alkali was needed to effect any marked degree of reduction of acidity. This rather indicated that only a portion of the lime acted directly upon the gas, the rest passing into the ash and clinker. Tests made, using very finely divided pulverised magnesium limestone, gave similar results.

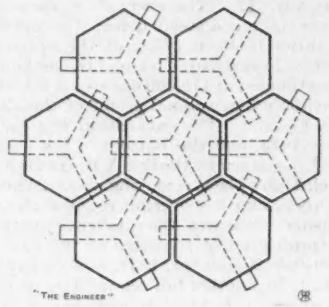
Arising out of these experiments, it was felt that perhaps a more efficient method of adding the lime would be to inject it in the form of a fine cloud directly into the combustion chamber, so that the reaction could take place directly between the lime particles and the sulphur acids away from coal and ash. Whilst there was some improvement in percentage drop of acidity, it was obvious that far too much lime would be required for the process for it to be of any real use. It has since been realised that the temperature above the hearth was too high for the reaction to take place. Investigation showed that this method of dealing with the problem had been anticipated, and experiments dealing with the injection of slaked lime powder for the specific purpose of reducing the acidity of flue gas at cooler spots in the boiler flues were not continued.

From information obtained and observations made during the carrying out of a great number of tests and analyses made in connection with such tests, it was concluded that perhaps a combination of "wet" and "dry" methods of dealing with the problem would have some success. This method consists in injecting into the flues at a spot sufficiently hot to be above the boiling point of water a slurry of slaked lime and water through atomising nozzles, so that the mixture is "flashed" into fine particles of lime and steam or water vapour, the fine particles of lime reacting more easily with the acids in the presence of the moisture. Only such amount of water is added as can be held in the flue gases without condensation at the temperature occurring in the body of the stack. This method offers the opportunity of utilising any alkaline liquid or waste available, such as lime sludge from any water-softening plant, as well as blow-down water. Experiments on these lines without specially designed arrangements, and because of the difficulty of collecting samples under industrial conditions, are not easy to carry out, although the practicability of by-passing a portion of the flue gases after the addition of the alkali has been contemplated. For the moment, owing to extensive additions to the station, such large-scale experiments have been postponed.

Whilst some of the methods tried and suggested may not, for the moment, appear very practicable, yet the problem of the removal of acidity is an ever-growing one, and it may be that with the growth in size of stations and the use of fuels still higher in sulphur, the time may come when some partial, if not full elimination of this noxious content of flue gas will be deemed to be necessary.

Iron Roads on Sand.

THE January number of our French contemporary, *Travaux*, contains an interesting article on sand roads paved with cast iron setts. The advantages of sand, instead of concrete, as a foundation are manifest. Cheapness, ease of making alterations, noiselessness, and resilience under vehicles are eminent among them. Unfortunately, Mr. Dreux, the author, does not discuss the problems of its employment, such as ease of deformation and the risk that it may be washed away in heavy rains. But with regard to the former he does remark that any deformation which does take place is in long waves, which give little trouble to motorists, and not in potholes. He lays a good deal of stress upon the merits of such roads when temporary diversions have to be carried out, and dwells upon the expedition with which the work can be done, its impermanent nature, and its cheapness. A fair amount of experience has been already gained with roads so built in France, and in 1935 no less than 300,000 of "Vialit" cast iron paving blocks were made. They are, as shown in the accompanying sketch, hexagonal in form. The upper surface is moulded in any pattern which is deemed most suitable for preventing skidding, whilst below there is a projecting hollow triangle with internal radial ribs and at each corner a projection. These projections intercalate when the setts are laid and distribute the load.



"VIALIT" CAST IRON PAVING BLOCKS

The sand bottom, apparently of any convenient depth, is smoothed by "striking" in the usual way and the setts are laid directly upon it. No bitumen or other jointing material is used. Hence the work can be done rapidly, a speed of 30 square metres per hour per workman having been attained. An interesting example of the work is a road 600 m. long near Dreux, which is laid on a sand embankment nearly 5 m. in height.

The setts are cast in two types, one for heavy, the other for light duty. In the latter the radius (presumably over the points) is 110 mm.; thirty-one setts go to the square metre, and each weighs 3·5 kilos. In the former the radius is 140 mm., with twenty setts to the square metre and a weight of 6·8 kilos. per sett.

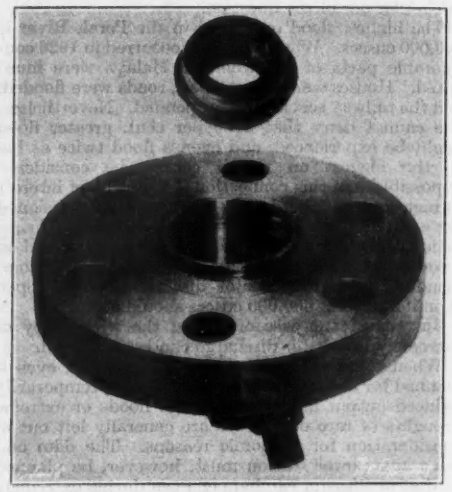
The Wave-Ring Pipe Joint.

WE have received from Imperial Chemical Industries, Ltd., of Millbank, London, S.W.1. some particulars of a new type of pipe joint, which has been developed at their laboratories in Northwich, Cheshire, for withstanding very high pressures. We give a sectional drawing of one of these joints, together with half-tone engravings of two that have been in actual service.

The objects aimed at in designing this joint were to save weight as far as possible, while maintaining an absolutely fluid tight joint and to permit the joint to be opened and remade a number of times without damage or re-preparation. To this end a bolted flanged joint is used, but no attempt is made to seal it axially. As a consequence the bolts have only to carry the axial thrust produced by the fluid pressure within the pipe and can be made correspondingly lighter than if they had also to provide a clamping force to produce a tight joint at the same time. The saving which can be effected in this way may be gauged by the following example:—Taking a 3in. main carrying superheated steam at a pressure of 565 lb. per square inch, an ordinary joint would require flanges 9in. in diameter by 1¼in. thick, screwed and welded on to the pipe. With a wave-ring joint flanges 6⅞in. in diameter by ¾in. thick are sufficient, and the pipe need only be screwed and expanded in place. Eight ⅝in. mild steel Whitworth bolts are sufficient.

Coming to the joint itself, it is made tight by radial pressure, somewhat after the fashion of a cup leather. As will be seen from the sectional drawing, a small rectangular recess is turned in each of the flanges. In the cavity formed by the two facing recesses, in the opposite flanges, the "wave-ring" is housed. This ring has an internal bore coincident with the bore of the pipes, and an outside surface with two waves. It is an easy fit longitudinally in the cavity, but is a force fit circumferentially. The ring may be made of a variety of metals according to the service for which it is intended. In assembling the joint the ring is tapped into one of the recesses with a wooden hammer and the other pipe is drawn over it by means of the flange bolts. The nuts are then slacked off, just hand-tight, so that the whole of the strength of the bolts is available to carry the axial fluid pressure thrust. There is no initial tension in the bolts.

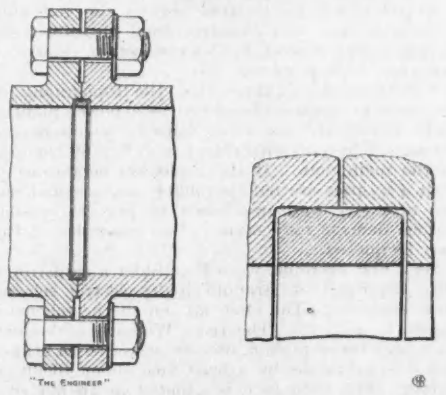
It will be appreciated that the forced fit of the ring in the recesses will provide an initial sealing that will resist low pressures, but is inadequate for the pressures contemplated—of the order of 40,000 lb. per square inch. For this reason the flanges and the ring are so proportioned that under increasing pressure the ring expands more rapidly than the flange, and the tops of the waves take a very powerful bearing against the recess, which resists leakage. It is generally intended that the ring should not



WAVE RING AFTER SERVICE, AND FLANGE

be stressed beyond the elastic limit, but should this be unavoidable a copper ring may be used and allowed to deform gradually as the pressure comes on. The half-tone engraving shows a small copper ring which successfully held a pressure of 175,000 lb. per square inch for a total duration of over 200 hours, during which time the joint was opened and re-made forty times without any re-touching of the ring or recesses. It will be noticed that the ring, which originally had the section as shown in the drawing, now has a thin fin round the middle. This fin has been caused by the metal flowing into the narrow crack between the flanges.

Wave-rings can, as a rule, be opened and re-made a considerable number of times without the need to reface either socket or ring. The firm refers to a joint which has actually been opened over 400 times without re-



ARRANGEMENT OF WAVE RING PIPE JOINT

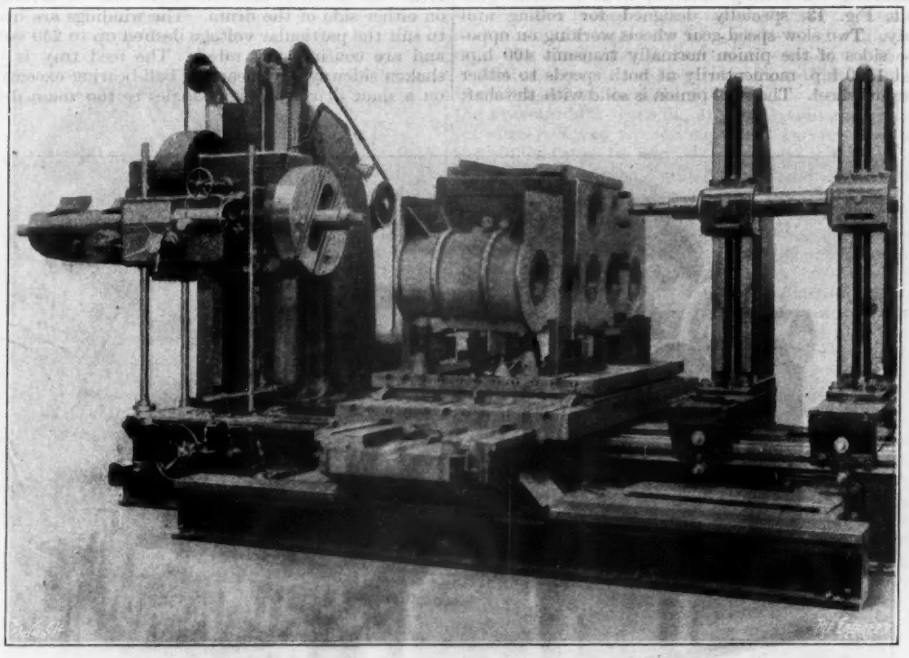
touching. Its working pressure is 700 atmospheres (rather over 10,000 lb. per square inch) and its service has so far extended for over three years. The sockets are made of "Vibrac" steel heat-treated to a tonnage of 60 tons per square inch, while the ring is of the same steel, but hardened to 80 tons per square inch. The use of materials of differing hardness is a useful factor in prolonging the life of the joint if it has to be frequently opened and re-made. Another useful expedient for such service is to make the rings of brass if the sockets are of steel. This confines the wear to the brass and, moreover, even if wear has proceeded to such an extent that the joint leaks, it is often possible to repair it by expanding the ring on a drift and refacing its surfaces.

A Large Horizontal Boring Machine.

WE illustrate herewith a large horizontal boring machine for locomotive cylinders which has recently been delivered to the Darlington Works of the London and North-Eastern Railway by H. W. Kearns and Co., Ltd., of Broadheath, Manchester. The machine is designed for surfacing, boring, milling, drilling and tapping work and is a modified version of the maker's No. 5 pattern. It is capable of dealing with the railway company's triple monobloc cylinder castings weighing about 5 tons. The main table, enlarged and strengthened to take this work, measures 10ft. by 5ft. and is fitted with a revolving table measuring 7ft. by 5ft. The traverse of the main table across the bed measures 8ft. 6in. The bed, of an

overall width of 10ft., is provided with extensions at the back and front to support the table and work when in the extreme positions.

The machine is capable of performing all the operations required on the castings. These operations include the boring of the three cylinders, the machining of the bell mouths, stuffing-boxes and piston valve chambers, facing the front and back ends, milling the frame faces and drilling and milling the ribs and bosses. The cylinder castings are each machined complete in forty-six hours, this time including two settings. They are mounted on the revolving table and can be machined on four sides without disturbing the setting. Two boring bar stays are fitted. The duplication of these stays provides extra support to the boring bar under heavy cuts and damps out any chattering tendency. The stay bearings are fitted with hinged caps and are adjusted vertically simultaneously with the spindle. In order to provide sufficient room to rotate the revolving table the bed has been lengthened 3ft. above the normal size with the result that a maximum distance of 12ft. 6in. is provided between the facing head and the boring bar stay.



BORING MACHINE FOR LOCOMOTIVE CYLINDERS

The machine is driven by a 25 h.p. motor through vee-belts and grooved pulleys. Twenty-four changes of speed ranging from 2 to 170 r.p.m. are available while in addition the motor speed is variable through a 2 to 1 range so that the twenty-four machine speeds can each be stepped up. There are sixteen rates of feed, arranged in two equal ranges. One range is derived from the spindle and provides eight boring feeds from eight to ninety-six cuts per inch. The second range provides eight milling feeds and is obtained from the constant-speed first motion shaft of the machine. These milling feeds are therefore independent of the spindle speed. They are available not only for milling but for drilling and also for fine finishing boring feeds. The normal range of the milling feeds is from 0·8in. to 10in. per minute but by means of a simple modification these figures may be halved or quartered. Hence in some cases feeds as fine as one-thousandth of an inch per revolution of the spindle can be used.

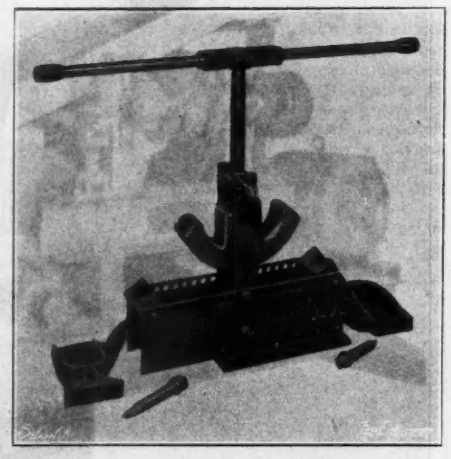
Sparking Plugs with Platinum Points.

SOME very interesting facts have come to light as a result of research work carried out by K.L.G. Sparking Plugs, Ltd., of Putney Vale, London, S.W.15. In the course of experimentation platinum points were fitted to a sparking plug, with the somewhat surprising result that besides a very much reduced burning there was also a great reduction in the working voltage. Further investigations were, of course, carried out after so favourable a beginning. One dealt with the curious circumstance that on observing the fine platinum points in action through the exhaust valve port they were seen to be at a very high temperature, more than sufficient under ordinary circumstances to produce auto-ignition. To elucidate the point loops of wire were fitted into two polé plugs and arranged to be heated to any required temperature by low-tension current. The engine fitted with this apparatus was then motored round at its ordinary speed and the temperature of the loop gradually increased until auto-ignition took place. Wire $^1/_{10}$in. diameter, the size of a normal plug electrode, gave rise to auto-ignition when it reached a temperature of 700 deg. Cent. But a platinum wire, 0·020in. diameter, a size that is now used for K.L.G. plugs, could be raised to a temperature as high as 1200 deg. Cent. before auto-ignition took place. Full advantage is taken of this ability of a fine platinum wire in the new productions of the firm. Owing to the fact that a lower voltage than usual can be employed, the normal width of gap can be maintained and the stress on the ignition equipment much reduced; or alternatively, a much wider gap can be arranged, giving a marked improvement of slow running. The firm recommends a compromise whereby the gap is made 0·020in. to 0·025in. with a consequent reduction of voltage and advantage in slow running and starting. Other advantages which the firm claims for plugs with platinum points are that the resistance of the metal to point burning is very high, so that the gap remains unaltered for a long time; that even after burning has taken place the consequent widening can go on to an extent that is far greater than with the ordinary plug without causing misfiring; that with a fine platinum point condensation troubles appear to be overcome, as there seems to be no tendency for a drop of water to remain bridging the gap; and lastly, that, on account of the low working voltage required, a platinum point will run satisfactorily even when the insulator is dirty. We understand from the firm that platinum-pointed plugs, to be known as P.K.1 plugs, are to be marketed to the public at a price very little above that of ordinary plugs.

A New Pipe Bender.

THE pipe-bending machine which we illustrate herewith is a new design being made by Power House Components, Ltd., of Albion Chambers, King-street, Nottingham, and is intended for forming, cold, steel piping, ranging from $\frac{3}{8}$in. to 2in. internal diameter.

As will be seen, it is really a very simple affair, following much on the lines of some other benders, but it is unusually adaptable, and can be used for making a variety of bends. Two plates, drilled near the top edge, are mounted on a base plate by means of angle irons and carry near the centre a column having a crosshead nut. A long square-threaded screw passes through this nut and is used to press down a former, to make a bend in the pipe. Other formers are pinned into the holes in the side plates and prevent the pipe being flattened or kinked as it is bent. The position of these formers naturally depends on the shape of the bend required. The screw is operated by a two-handed ratchet lever and foot grips are provided for the workmen to steady the machine. For some kinds of bends it is preferable to lie the bender on its side, and the foot rests then come in handy for extending its base on the floor. One end of the ratchet lever is then unscrewed and screwed into the handle of the other lever, so as to increase the purchase and clear the ground. The formers for different sizes of pipes are easily changed over.



PIPE BENDING MACHINE

American Engineering News.

Chemical Precipitation for Sewage Treatment.

IN the wide and rapid extension of sewage treatment in the United States there is a notable revival of chemical precipitation, with prospects of a further increase, but mainly to supplement other processes. Of some 3500 cities having sewage treatment works, 34 have chemical processes in use, and 10 others have such works under construction, while 26 others have them under consideration or experimentation. Ferric chloride is most generally used, sometimes with lime also. Other chemicals include chlorinated copperas, with or without lime; ferrous sulphate and lime; iron salts; lime; and lime in combination with alum. The plants are of diverse sizes, with capacities from 24 to 500,000 gallons daily. Originally the chemical process was a promoter's field, with patents and expensive chemicals as features, rather than a basis of technical or engineering design. As a result of the consequent operating troubles, the high cost of treatment, and the great volume of sludge produced, the process in general fell into disfavour and most of the plants abandoned its use. While no new chemicals for precipitation have been developed, the cost of those which are most effective has decreased considerably, while the sludge problem has been practically solved by new mechanical appliances. In general, the process is an advance beyond simple sedimentation, and in cases where secondary treatment is required the chemical precipitation as a preliminary reduces the burden upon the biological processes now in use. Furthermore, the recent revival and adoption of chemical treatment is based on the known merits of the system as applied by competent engineers rather than on proprietary methods and materials. In several cases the chemical treatment is for use under special rather than regular conditions, or in connection with trade wastes disposal. Thus for the new works at St. Paul, serving a population of nearly 750,000, chemical precipitation will supplement sedimentation only during the five-month summer period of low flow in the Mississippi River.

American Sewage and Trade Wastes Plant.

New sewage works at Cedar Rapids, U.S.A., are designed to handle a trade waste load equal to the load from domestic sewage. The city has great meat-packing industries, and they share the cost of construction and operation of the treatment plant. For the domestic sewage there is a rack-screen, with sludge gas furnace to dispose of the screenings; then a grit remover, grease remover, radial-flow clarifier, four straight-line clarifiers for peak loads, chlorinator for odour control, twin dosing tanks, trickling filters, and final clarifiers. All sludge is delivered to a battery of digestion tanks, with gasholder, the gas being used in an engine which drives a generator supplying current for all the sixty-eight electric motors. The digested sludge is treated with ferric-chloride and lime, and either dewatered in a vacuum filter or spread on drying beds. The trade waste from the meat-packing houses is first passed through grease traps and screens, and then to a storage tank from which it flows to a grease remover, radial-flow clarifier, and a mixer for the addition of sulphuric acid, with ferric-chloride as a flocculating agent. After passing through a flocculator and a secondary clarifier, the effluent is pumped to the dosing tank of the sewage plant, where it is mixed with the city sewage before passing to the filters. The flocculated sludge goes to the sewage sludge and is pumped with it to the digestion tanks. All other trade wastes, from dairies and corn-product plants, are discharged directly into the city sewers. This combined sewage has a flow of 6,500,000 gallons daily, to which the meat-packing houses add 1,250,000 gallons. The filter cake from the vacuum filter drum falls upon a conveyor belt 100ft. long, and is discharged into wagons, while the filtrate flows back to the raw sewage main. The engine driven by the sludge gas is a five-cylinder machine, driving a 150-kW, 2300-volt generator.

Slag Control in Steel Manufacture.

The control of slag, as an important factor in the manufacture of iron and steel, has been the subject of a series of papers issued by the American Institute of Mining and Metallurgical Engineers. Advance in the art of slag control has been marked in the past few years. The viscosimeter method for slag-reaction rate and composition, together with the phosphorus and other methods, enable the manufacturer to rectify and control the slag in the finishing period of the heat with much greater precision than before. But to make steel of desired analysis in the most economical manner, the constitution of the initial slag is of primary importance, as it is a factor in determining the carbon content of the charge. Therefore, the aim is to so regulate the slag-making additions that a suitable initial slag will be formed. A novel development is the use of equilibrium diagrams plotted on a large scale, as those published in scientific journals are too small for practical use. The scale is sufficiently large to permit of interpolations of 0·10 per cent. The general subject of slag control was dealt with from various points of view—that is, its application to the blast-furnace, low-carbon steel, basic open-hearth high-carbon steel, rimming steel, alloy forging steel, recarburised rail steel, acid open-hearth steel, and basic electric furnace steel. In the production of this last grade of steel two separate types of slag are involved; first, the oxidising slag, which is generally removed from the furnace by mechanical means, and then the second, deoxidising or finishing slag. As to the size of electric furnace, it is found that slag can be controlled as easily in 100-ton furnaces as in those of smaller capacity. With the introduction of the forty-hour week it has become of increased importance that a definite method of procedure be followed and that practice be standardised in order to eliminate the human element as far as possible. As to the blast-furnace, the variations in slag analysis in different parts of the furnace are sometimes so extreme that control is a difficult problem.

The British Industries Fair at Birmingham.

No. II.

(*Continued from page 173, February 14th.*)

J. B. STONE AND CO., LTD.

AN improved form of nibbling machine is to be seen on the stand of J. B. Stone and Co., Ltd., of Chiswell House, 135, Finsbury-pavement, London, E.C.2. The machine forms part of a range designed to cut sheet metal from $\frac{1}{32}$in. to $\frac{5}{16}$in. thick into intricate shapes when the small number of products does not justify the making of dies. The medium sizes of this range are now fitted with a variable stroke. In the standard machine, the spigot on the end of the shaft is concentric and the excentric sleeve, which is mounted on the spigot, gives the one stroke. With the new type nibbler, the spigot is itself excentric, and by turning the excentric sleeve to the three different positions provided, three different lengths of stroke are obtained. This improvement enables the operator to cut thicker or thinner material without the use of a thicker template. Previously, a thick template had to be used when cutting thin material, but now the nibbler will cut material from $\frac{1}{16}$in. to $\frac{3}{16}$in. thick with templates only $\frac{1}{8}$in. thick.

The machine operates at approximately 20 linear inches per minute, operating 350 strokes per minute. The main bearing is fitted with sight feed lubrication, and the drive is by belt to a 12in. diameter by 2$\frac{1}{2}$in. face pulley running at 350 r.p.m. A foot-operated clutch is provided. The machine has a depth of throat of 12in., a height of 4ft., and requires a floor space of 2ft. 9in. by 1ft. 6in. A $\frac{1}{4}$in. punch is used.

HENRY SIMON, LTD.

Among the exhibits of Henry Simon, Ltd., of Cheadle Heath, Stockport, are a two-roller mill for maize flaking, bran rolling, and similar work involving extra high pressure, and a vertical cooker, Fig. 12, for cooking maize or maize grits, wheat, and other

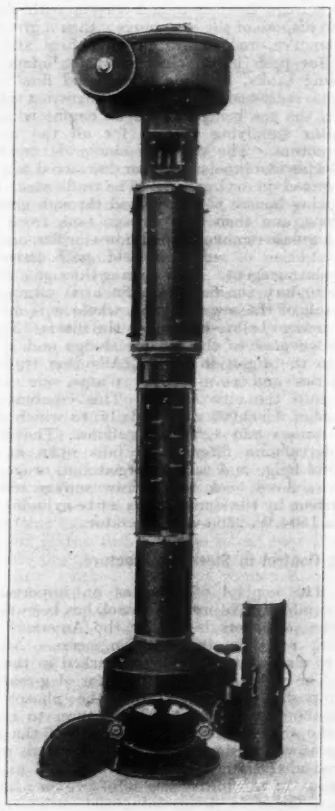


FIG. 12—VERTICAL CEREAL COOKER—SIMON

cereals prior to flaking. The upper part of the tube is steam jacketed, so that the grain is initially heated before it comes into contact with the live steam injected into the section below by means of a central rotating spindle to which jets are attached. The cooker is lagged throughout and is covered with planished steel. An automatic weighing, blending, and mixing unit, shown in operation, represents the firm's apparatus for proportioning, mixing, controlling, and capacity recording non-free-running materials, particularly cattle feeds, powders, and similar materials. The firm's soap-making machinery is represented by a five-roll soap-flaking mill for large outputs of the thinnest flakes. The five chilled steel rolls are water cooled and provided with an exceptionally sensitive and accurate form of adjustment. The associated firm, Barron and Son, Ltd., is showing on the stand a "Diamond" corn cutting and grading unit, an impact grinder with an electric motor built into the frame, and a self-contained electrically driven fan for pneumatic delivery. There is also a sifter and mixer for blending all classes of dry and lumpy powders.

Turbine Gears, Ltd., another associated firm, is exhibiting the totally enclosed double helical gear unit, Fig. 13, specially designed for rolling mill duty. Two slow-speed gear wheels working on opposite sides of the pinion normally transmit 400 h.p. and 1800 h.p. momentarily at both speeds to either output wheel. The steel pinion is solid with the shaft and both gear wheels have forged steel rings shrunk and pegged on semi-steel centres, the teeth of the gear wheels being hob generated. The bearings are force and spray lubricated respectively by a gear type pump driven through a chain from one of the slow-speed shafts. Visible oil flow indicators are fitted on all pipe lines.

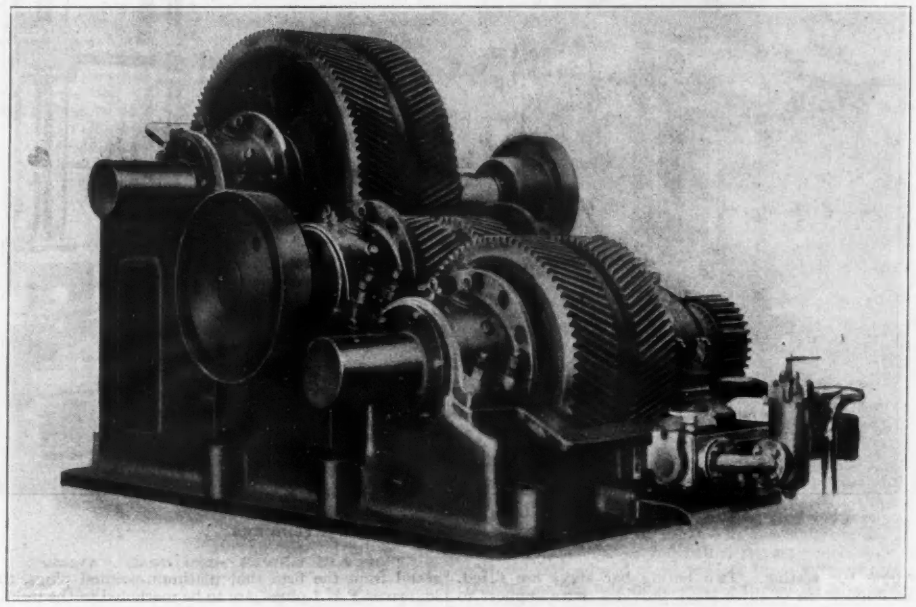


FIG. 13—DOUBLE HELICAL GEAR UNIT—TURBINE GEARS

THE RAPID MAGNETTING MACHINE COMPANY, LTD.

The Biaflux drum type electro-magnetic separator illustrated in Fig. 14 is exhibited by the Rapid Magnetting Machine Company, Ltd., of Magnet Works, Lombard-street, Birmingham, 12. The machine is available in various diameters and widths of drum, the particular one illustrated having a 30in. diameter and 18in. width. The drum revolves at 25 to 30 r.p.m. It is driven by a motor mounted at the back of the frame, speed reduction being obtained by means of an intermediate shaft and by the chain drives used. For use on an A.C. supply a D.C. generator for energising the magnets is coupled to the motor shaft. The magnet unit is of a special shape designed to eliminate "dead spots." It is mounted on a shaft having fixed bearing brackets and arranged to allow for radial adjustment of the magnets by means of a tommy bar used at the external end of the shaft. Around the magnet unit revolves a totally enclosed drum having non-magnetic flanges and having a dustproof cover. It is of built-up construction, special alloy plates being used which are detachable and replaceable without disturbing the drum or the dustproof cover. The bearing bosses of the drum are arranged for grease lubrication, and the drive can be arranged on either side of the drum. The windings are made to suit the particular voltage desired up to 250 volts, and are continuously rated. The feed tray is jig-shaken sideways by means of ball-bearing excentrics on a shaft driven at right angles to the main drive through bevel gears, the excentrics, &c., being dust-protected. The feed tray makes 250–300 movements per minute. It will be seen that as the magnet units are held stationary in the front half of the drum only, and as the drum is revolving, any iron is magnetically held against the drum face until it reaches a position near bottom dead centre, whence it falls by gravity. The magnets are controlled by a shunt break switch fitted with a non-inductive resistance for absorbing the back E.M.F. The machine can also be fitted with a red pilot lamp to indicate whether the magnets are energised. The advantage claimed for the magnetic drum over the magnetic pulley is that no belt need lie between the material and the magnetic force, so that a very considerable magnetic insulation is removed from the field of the magnets.

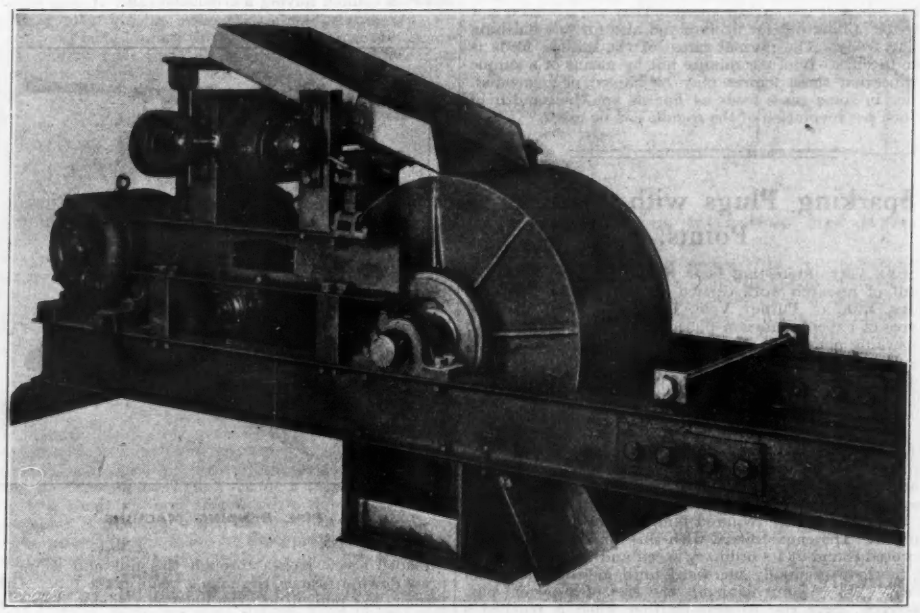


FIG. 14—ELECTRO-MAGNETIC SEPARATOR—RAPID MAGNETTING

JOHN SHAW AND SONS (SALFORD), LTD.

The firm of John Shaw and Sons (Salford), Ltd., of Wellington Works, Salford, is exhibiting three-throw

vertical hydraulic pumps, one a 30 h.p. set, and the other a 60 h.p. set. The pumps are of special design and fitted with forced feed lubrication to the bearings, the crankshaft being drilled through for oil circulation. This arrangement avoids the necessity of constantly attending to lubricators and results in a higher efficiency. On the stand there is also a horizontal forging press, 200 tons capacity, to admit work up to 57in. diameter and 97in. long. This press is driven from a pump carried on the press head.

A portion of the exhibit is devoted to machinery for the plastics industry. Illustrated in Fig. 15 is an 80-ton press for synthetic resin moulding, which is controlled by either push buttons or by an electric clock, which operates the press at the end of a pre-set curing period. A tableting machine is also shown. This tool weighs the moulding powder before pressing and compressing it into shapes to suit the mould in the press. For the newer process of injection moulding of cellulose acetate compounds, the firm is exhibiting a 10-ton vertical press driven from an enclosed hydraulic pump. This press is being operated during the Fair for demonstration purposes.

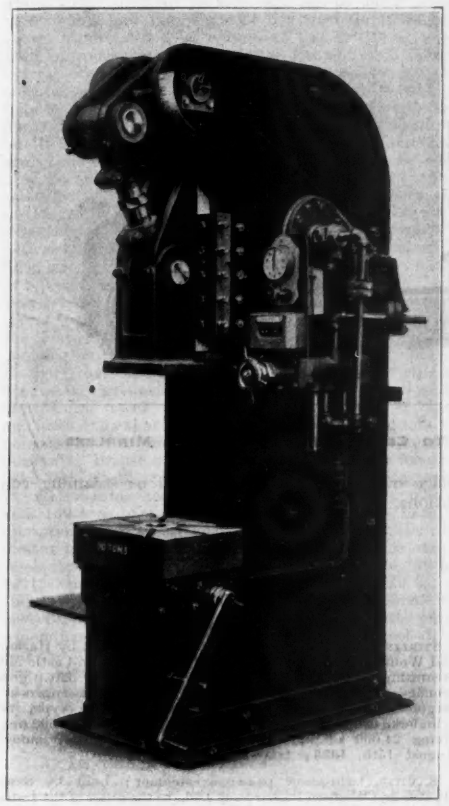


FIG. 15—80-TON MOULDING PRESS—SHAW

GEORGE H. ALEXANDER MACHINERY, LTD.

The firm of George H. Alexander Machinery, Ltd., of 82–4, Coleshill-street, Birmingham, 4, manufactures and imports a variety of engineers' requisites, and there is a representative display on the stand; but many of these have already been described in THE ENGINEER, notably the Rockwell hardness tester and the Alexander-Erichsen pattern sheet metal testing apparatus, which were shown at the Fair last year. There is also a variety of chucks, reamers, form tools, and gauges, the latter ground by an optical method by Precision Grinding, Ltd., Mordenroad, Mitcham, Surrey. The A.B. hone, illustrated by the section Fig. 16, is intended for such work as finishing the bores of motor engine cylinders, and is said to have reduced the time occupied by 75 per cent. and more, while the accuracy has been doubled or quadrupled as compared with grinding. As these hones are self-aligning, they can be used in practically any drilling machine.

Referring to the drawing Fig. 16, which gives longitudinal and transverse sections, it will be observed that the expansion is obtained by means of a pre-loaded or caged compression spring of an unusual type. This spring consists of alternate plain and ribbed washers, the ribbed members having two ribs at right angles on opposite sides. Thus when a series of these washers is clamped up on a sleeve the washers bend across the diameter, giving a very powerful spring, and one, moreover, which is easily controlled and uniform in action, since the washers can be accurately surface ground to any desired thickness. In the type of hone shown the washers are normally loaded to approximately 80 lb. pressure, and when the expansion is applied by the knurled adjusting sleeve the pressure is increased to 85 lb. or 90 lb. according to the stock removal. A point to be noted is that the hone will continue cutting until the pressure falls to 80 lb., at which point the spring pressure is taken by the cage, and the pressure on the stones drops to zero, so that there is a more or less uniform cutting action. The stone holders are expanded in the usual manner by means of opposed floating cones and the thimble is graduated in ¼-thousandths of an inch. The cross section view of the hone shows the patented tangential construction, which gives the maximum support to the steel shoes carrying the stones when the hone is running right-hand. The reaction of the cutting pressure is also utilised to hold the stones on the seating so that they may be put on with shellac instead of the former method of having to set them in babbitt.

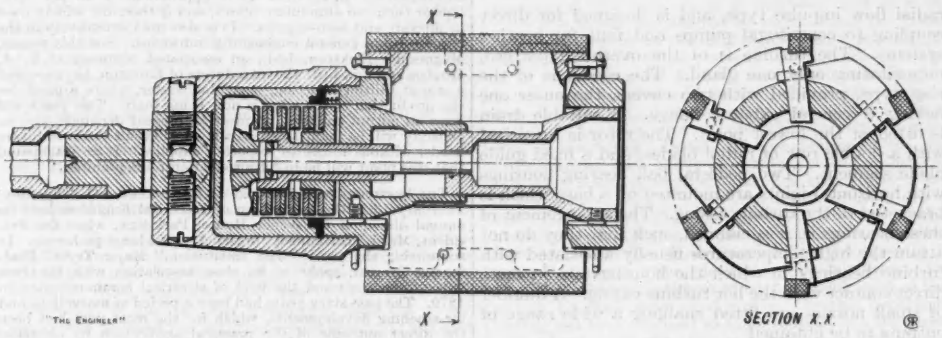


FIG. 16—THE A.B. HONE—ALEXANDER

LINER CONCRETE MACHINERY COMPANY, LTD.

In Figs. 18 and 19 are illustrated two models of the "Cumflow" concrete mixer, manufactured by the Liner Concrete Machinery Company, Ltd., of Glasshouse Bridge, City-road, Newcastle-upon-Tyne. The principle on which these mixers work is that if the pan rotates slowly in the same direction as the central "star" or paddle, the maximum number of intersections occur in the paths of the pan and of the paddles. To this end the star carries a number of fixed mixing blades, the angles of which are such as to obtain the maximum number of points of intersection. The pan revolves beneath them at a much slower speed, feeding the materials into the star. Further mixing action is obtained by a fixed side blade, which not only turns the batch over, but also feeds it into the mixing star, thus ensuring that at each revolution of the pan all the contents are passed through the central star and ensuring that balling or separation does not occur. The pan and star revolving in the same direction provide the advantage that although the feed to the star is rapid, the material cannot pile up against it, but is dealt with steadily as the feed occurs. For this reason large batches can be fed into the pan. The action of the star during emptying causes the whole of the pan contents to be removed, a discharge blade being lowered to rest on the bottom of the pan at the same time as the discharge door is opened. When mixing certain aggregates, such as facing material, tile concrete, &c., the mix is sometimes improved by using an independent roller. This roller backs up the work of the blades by causing a kneading or rubbing action. Not only is the roller hinged so that it rides on top of the material, thus avoiding any action of crushing, but means are provided to fix it definitely at any required distance from the pan bottom. The machine may be had either with or without a fixed-type hopper or a power-driven batch loader driven through machine-cut gears and a clutch. The loader consists of a hopper carried on two wheels which run on rails. Hoisting is by a single line, which runs from a reel, under the hopper and over a second reel, so that the two reels take up the line together, the line being drawn off the second reel to the winding drum. An ingenious single-lever control provides braking in the central position of the lever with "hoisting" or "lowering" at opposite ends of the movement. Automatic braking is provided when the hopper reaches the top of its runway. A water tank, which is self-measuring, is also provided, the discharge being graduated in gallons so that when the lever is placed at a given figure, that number of gallons of water will discharge and no more. The machines can be supplied with a Lister petrol, paraffin, or oil engine as a self-contained unit or with direct electric motor drive as an alternative to fast and loose pulleys. A feature of all Liner machines is the use of roller or ball bearings on all moving parts. The "O" size machine shown in Fig. 19 differs from the larger machine in that instead of a discharge door being fitted the pan is made detachable. It can thus be removed and replaced by a second pan enabling small quantities of different aggregates to be made up, and is particularly useful where different colours are required. The Liner portable engine-driven brick-breaker, illustrated in Fig. 17 is available with the alternative drives offered for the mixers. It has a steel underframe with swivel forecarriage and broad tread wheels. Solid rubber-tired wheels are available if required. The frame is cast in "semi-steel" in one piece. A heavy iron casting forms the jawstock. The head is bored to take an adjustable gun-metal bearing made in two parts adjustable for wear by means of two wedge keys. The jaws are of manganese steel, adjustable end for end. Two balanced fly-wheels are fitted to the crankshaft,

FIG. 17—BRICK-BREAKER—LINER CONCRETE

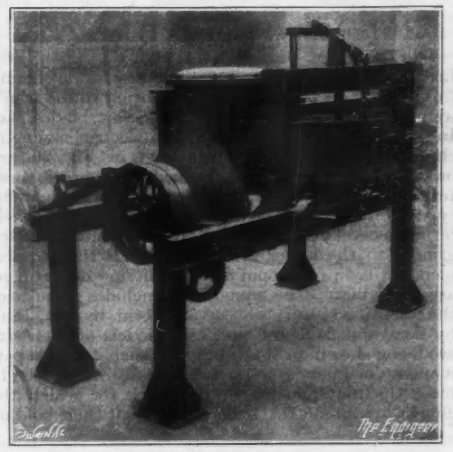


FIG. 18—"CUMFLOW" CONCRETE MIXER—LINER CONCRETE

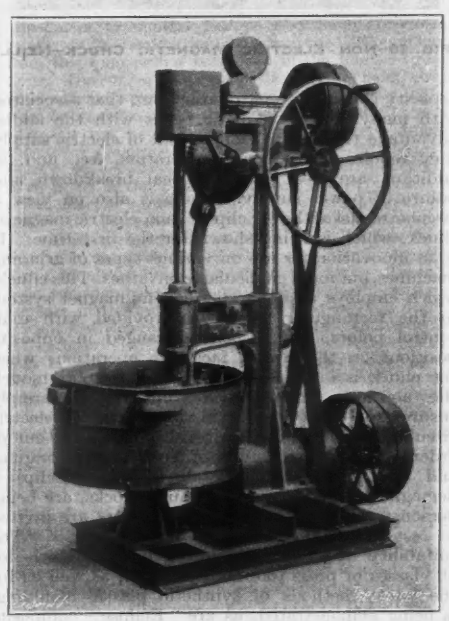


FIG. 19—SMALL "CUMFLOW" CONCRETE MIXER—LINER CONCRETE

which is forged from 50-ton high-tensile steel. It runs in white metal bearings. The toggle plate is of cast iron, and produces a combined vertical and horizontal movement of the jawstock, giving two crushing blows per revolution. The ends of the toggle plate are let into steel liners which are renewable and take the wear which would otherwise act on the jawstock and grooved block. The grooved toggle block and the jawstock are adjustable during running to regulate the size of the crushed material. The grooved block is locked by wedge bolts. Stauffer greasers are fitted to the machine. The drive is by belt, and if required fast and loose pulleys can be fitted.

JAMES NEILL AND CO. (SHEFFIELD), LTD.

The stand of James Neill and Co. (Sheffield), Ltd., is designed to represent a hacksaw blade cutting through a steel bar. It draws attention to the firm's well-known line of "Eclipse" hacksaws, blades, &c. In addition, the "Eclipse" non-electric magnetic chucks, one of which is illustrated in Fig. 20, are on view. Since last year a wider range of these products has been introduced. In the rectangular type the range has been extended to include models for all general classes of work, from the small surface grinder to the larger grinders, so that the requirements of both tool-room and production department are fully met. The range now includes chucks of the following sizes: 10in. by 5in., 14in. by 6in., 18in. by 6in., and 24in. by 8in., and models of each size are being shown on the stand. In each case the permanent magnet system is specially designed to meet the requirements of the work for which the chucks are intended. It is claimed that their holding

FIG. 20—NON-ELECTRIC MAGNETIC CHUCK—NEILL

capacity is equal, if not greater than, that associated with many electro-magnetic types with the added advantage that being independent of electric supply they require no rectifiers, generators, &c., and, in addition, are free from electrical breakdown and failure of power supply. There is also on view a circular model of the "Eclipse" non-electric magnetic chuck, which is being shown for the first time. It is an innovation for use on various types of grinding machines, but more particularly on lathes. This chuck, which employs a similar permanent magnet system to the rectangular model, is provided with dual control points, which, being arranged in opposite positions on the chuck, facilitate operations when the chuck is in use. As in the rectangular model, the absolute independence from electric supply ensures trouble-free operation, since in the non-electric circular model there is no brush gear to get out of order. Interesting details of both the rectangular and circular models, as well as the "Eclipse" demagnetisers and magnetic chuck blocks, are being demonstrated upon the stand. Visitors are invited to test the holding capacity of the chucks. The suitability of "Eclipse" special crucible steels for all classes of press tool and die work, as well as for the latest methods of synthetic plastic moulding, is being demonstrated, as are "Eclipse" composite steel (steel-faced iron) and "Eclipse" super high-speed tool bits.

MIRRLEES BICKERTON AND DAY, LTD., AND THE MIRRLEES WATSON COMPANY, LTD.

The most prominent feature on this stand is the "Mirrlees-Combustioneer" automatic stoker, manufactured by Mirrlees, Bickerton and Day, Ltd., at Hazel-grove, Stockport, two examples of which are on view, showing the latest design and construction adopted by the firm for central heating duties. The engraving reproduced in Fig. 21 shows the stoker attached to a standard central heating boiler, the side of which has been cut away in order to show details of the method of application. It clearly indicates the fire brick hearth and the retort, with its side tuyeres, giving air supply. The air is furnished by a motor-driven fan, with an adjustable air regulator, which delivers the air at the proper pressure by changing the effective width of the fan. The motor is enclosed in a dust-tight casing, and also drives the intermittent type gear-box, which operates the coal-feed worm. In the larger machines a safety clutch is provided, which disconnects the feed worm should an obstruction be met with, while an access plate is fitted, enabling the worm to be cleared without emptying the hopper. The feed worm is made of special wear-resisting alloy steel, and all wearing parts are hardened and ground. Various arrangements for automatic control can be supplied, either of the thermostatic or pressure control type. All working parts are enclosed and the fuel hopper is furnished with a gas-tight lid.

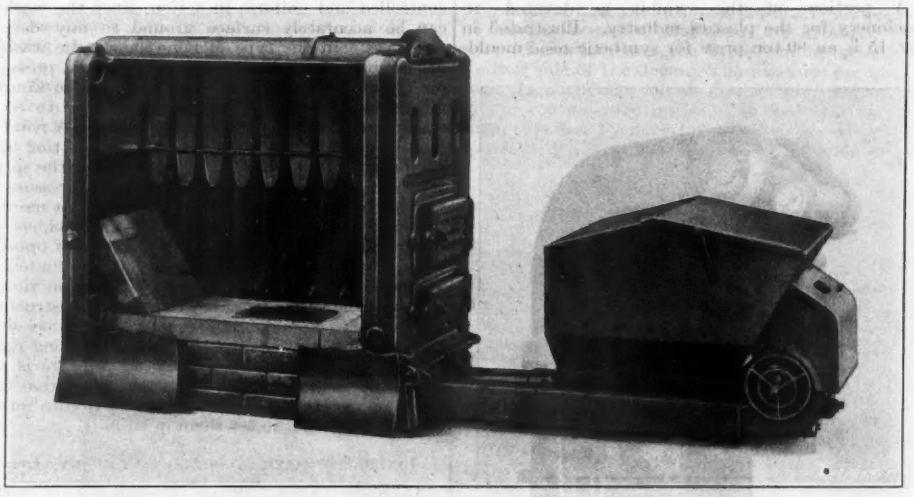


FIG. 21—"COMBUSTIONEER" STOKER FITTED TO CENTRAL HEATING BOILER—MIRRLEES

The associated firm, The Mirrlees Watson Company, Ltd., of Scotland-street, Glasgow, is represented by a series of pumps specially designed for use in connection with heating and ventilating systems. They include the firms "Clearway" circulating pump and a vertical self-priming pump, both of which we have described previously. Other exhibits, one of which we have chosen for illustration, include small steam turbines for pump driving and other industrial uses. The turbine is illustrated in Fig. 22, is of the

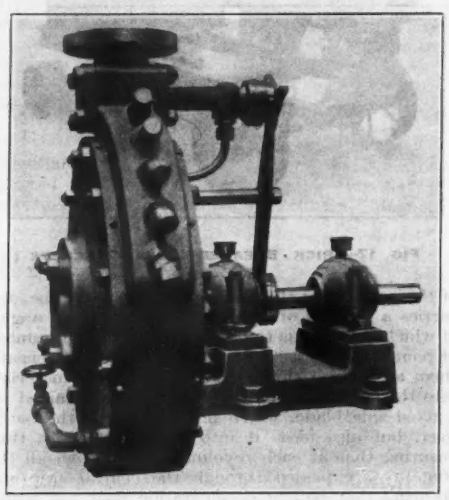


FIG. 22—RADIAL FLOW IMPULSE TURBINE—MIRRLEES

radial flow impulse type, and is designed for direct coupling to centrifugal pumps and fans for heating systems. The turbine is of the overhung pattern, necessitating only one gland. The casing is of the ring type, provided with two covers, the outer one having a central exhaust flange. A suitable drain is fitted at the lowest point. The rotor is furnished with a double row of radial blades, and a fixed guide blade segment. Two pedestal ball bearing housings with horizontal joints are mounted on a base which is bracketed to the turbine casing. The arrangement of these bearings is, it is claimed, such that they do not attain the high temperatures usually associated with turbine bearings in which the housings are in more direct contact with the hot turbine casing. A number of small nozzles are fitted enabling a wide range of outputs to be obtained.

There is a simple overspeed device consisting of a disc with a hinged weight controlled by a spring, which comes in contact with a lever when the tripping speed is reached. The lever engages in a notch provided on the handle of the trip valve, which closes when the lever disengages, owing to the action of the hinged weight referred to above. The trip valve of the butterfly pattern is situated in the turbine casing immediately above the steam chest. As the trip valve spindle is of stainless steel, it does not require any gland packing, and it is contained in a sleeve of suitable length fitted with a drain. A point of interest is that this turbine can have its rotation reversed after arrival on site without altering the position of inlet and exhaust, or the supply of any new parts. The turbine being fitted with a number of nozzles also permits the duty to be increased or reduced to suit clients' requirements at a later date, which may take place owing to variation of load or steaming conditions.

(To be continued.)

LAUNCHES AND TRIAL TRIPS.

STIRLING CASTLE, twin-screw motor liner; built by Harland and Wolff, Ltd., Belfast, to the order of the Union-Castle Mail Steamship Company, Ltd.; dimensions, 725ft. by 82ft.; gross tonnage, 25,550 tons (approximately); to carry passengers and cargo. Oil engines of Harland B. and W. type, ten cylinders, 660 mm. diameter, and piston stroke of 1500 mm., giving 24,000 s.h.p.; constructed by the builders; launch, August 15th, 1935; trial trip, recent.

RAMDAS, twin-screw passenger steamer; built by Sawn, Hunter and Wigham Richardson, Ltd., to the order of the Indian Co-operative Navigation and Trading Company, Ltd., Bombay; dimensions, 179ft. by 29ft. by 11ft.; to carry passengers. Steam engines, triple-expansion; constructed by the builders; launch, January 9th. A speed of 14¼ knots was attained on trial trip recently.

A TWO-STAGE AIR COMPRESSOR.—Under the foregoing title we published an illustrated article on page 184 of our last issue descriptive of a compressor designed particularly to meet the conditions of high temperature and high altitude likely to be encountered overseas. This plant, we omitted to mention, is made by Holman Brothers, Ltd., of Camborne.

THE FARADAY SOCIETY.—The Faraday Society has arranged to hold a three days' meeting on Monday to Wednesday, April 20th to 22nd, 1936, in the Chemistry Lecture Theatre of the University of Leeds. The meeting will take the form of a general discussion on "Disperse Systems in Gases, Dust, Smoke, and Fog," which will be divided under two headings:—(i) "General," with a general introduction by Professor R. Whytlaw-Gray; and (ii) "Special," with a general introduction by Dr. R. Lessing. The times of the sessions will be as follows:—Monday, opening session 2.30 to 6 p.m. Tuesday, 10 a.m. to 1 p.m. and 4 p.m. to 6.30 p.m.; 2 p.m. to 4 p.m., exhibition; 7 p.m., informal guest night dinner. Wednesday, 10 a.m. to 1 p.m. Further particulars may be obtained from Mr. G. S. W. Marlow, secretary of the Physical Society, 13, South-square, Gray's Inn, W.C.1.

ELEKTRON MAGNESIUM ALLOYS.—Elektron is a magnesium alloy with a specific gravity of 1·81 to 1·83 with high strength/weight ratio, resistance to fatigue and freedom from embrittlement in service. It is approximately 40 per cent. lighter than the aluminium alloys, and is therefore widely used in aircraft and aero-engines. It is also used extensively in the electrical and general engineering industries. For this reason, Magnesium Elektron, Ltd., an associated company of F. A. Hughes and Co., Ltd., the introducers of Elektron, have secured a site at Clifton Junction, near Manchester, where a plant for the production of the alloy is now being built. This plant will have an output sufficient to meet all present demands, and its capacity will be maintained at a level sufficient to cover future needs, without resort to imported supplies. It is anticipated that this plant will be in full production by September.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—On Thursday, February 13th, the Institution of Electrical Engineers held its annual dinner at Grosvenor House, Park-lane, when the President, Mr. J. M. Kennedy, presided over a large gathering. In submitting the toast "The Institution," Major Tryon, Postmaster-General, spoke of its close association with the Post Office, which entered the field of electrical communication in 1870. The past sixty years had been a period of marvellous and far-reaching developments, which for the most part had been the direct outcome of the practical application by electrical engineers of the results of scientific research, invention, and discovery. In responding, Mr. J. M. Kennedy said that so far as the telephone side of the Post Office was concerned and the whole of the electric supply business, both had a common ancestor in the inventive genius of Michael Faraday. Many of the problems with which the Post Office had to deal were analogous to those in the electric supply industry. The main problem which confronted both was to make consumers or potential consumers appreciate the service offered. Other speakers were Lieut.-Colonel A. G. Lee, Engineer-in-Chief of the G.P.O.; Mr. J. Chuter Ede, Chairman of the London and Home Counties Joint Electricity Authority; and Sir Enoch Hill, President of the Chartered Institute of Secretaries.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

Another Steel Agreement.

The discussions that have been proceeding for several months between the British and Continental steel makers as to the method to be employed in handling the imports of Continental steel resulted in an agreement in principle which was reached at the end of last week. The British makers appear to have gained their point, and the whole of the steel imported from Cartel countries will be booked to the British Iron and Steel Corporation, which is the British steel makers' central organisation, and will be returned to the Continental selling agencies in this country which will distribute it under the supervision of the Corporation. Some details of the scheme have yet to be worked out, but it is understood that the arrangements entered into some time ago with a number of merchant firms, by which they became known as "privileged merchants," will be cancelled. It has been decided that f.o.b. prices shall no longer be quoted for Continental steel to buyers in this country, who will have to make their purchases on delivered terms. The prices of the imported steel will be fixed and its destination decided by a committee formed of representatives of British steel makers and the Cartel. The position of the merchants seems to be seriously threatened, as they will have to obtain their steel from the Continental selling agencies, which will allow them a commission out of the commission they themselves receive from the Continental makers. It is expected that sharp advances will be made in the prices of the Continental steel released for distribution in April, and that after that date the Continental steel quota will be released for sale in this country at three-monthly intervals. British steel prices were advanced at meetings held last week, the quotation for billets being raised 7s. 6d., making the price for untested billets, 500-ton lots, 100 tons of a size, £5 17s. 6d. For sheet bars the quotation has been advanced 5s. to £5 15s., but the most violent upward movement has been made in the case of small steel bars, which, from £8 14s. 6d. d/d London and £8 12s. provinces, have been advanced 9s. to £9 3s. 6d. and £9 1s. respectively. The price increases in small bars have been one of the remarkable phenomena of the period which has followed the application of the steel duties and the formation of the British Iron and Steel Federation. From prices which varied between £6 15s. and £7 an advance was made to £8 12s. d/d provinces and £8 14s. 6d. d/d London, and now the quotation has been raised a further 9s.

An Increase in Steel Imports.

The Board of Trade returns for January show an increase in the imports of iron and steel to 119,917 tons from 112,993 tons in December, and it is an interesting circumstance that the figures are very close to those for January, 1934, when the total reached 119,819 tons. It will be remembered, however, that by the Anglo-Continental steel makers' agreement the Cartel's import quota was based upon the 1933 figures, and in January of that year the total of foreign steel imported was 69,500 tons. No doubt, monthly comparisons are not very reliable as a guide, and if there was a large excess in January, adjustments will be made in later months. The imports of pig iron in January were down from 8910 tons in December to 6706 tons, the reduction being entirely in the imports from India. There was a slight increase in the imports of blooms, billets, and slabs from 34,140 tons in December to 38,168 tons in January. Belgium, as usual, with 9938 tons, sent the largest quantity, France being a close second with 9873 tons. Imports from Germany reached 6219 tons. The quantities sent in from British countries, however, fell from 8440 tons to 7143 tons in January. There was also an increase in the imports of sheet bars to 11,455 tons, compared with 10,132 tons in December, and of the January total 10,549 tons came from Belgium. Imports of general descriptions of steel increased to 15,659 tons last month, compared with 14,705 tons in December, whilst there was a slight decline in the quantities of girders, beams, joists, and pillars brought into the country, from 5982 tons in December to 5291 tons last month. Imports of hoop and strip showed a substantial increase to 8684 tons, compared with 4758 tons in December, and it would seem that in this case the quota has been temporarily exceeded. The quantities of plates and sheets imported rose from 4004 tons in December to 4540 tons in January. Railway material was imported to the extent of 3790 tons last month, compared with 2882 tons in December, but there was little change in the imports of wrought tubes, the figures being 2232 tons and 2219 tons for January and December respectively. The largest supplier in January was Belgium, with 47,498 tons, France coming next with 15,720 tons and Germany third with 13,785 tons, whilst Luxemburg sent 11,538 tons. Of British countries, Canada sent 13,112 tons and India 4263 tons.

Iron and Steel Exports.

The exports of iron and steel in January fell to 164,772 tons, compared with 190,308 tons in December, but at the same time they followed closely the figures for January, 1934, when the total was 162,191 tons. It is interesting to note in this connection that the export agreement between the British steel makers and the Cartel is based upon the 1934 figures. The exports of pig iron declined in January to 6740 tons, compared with 9308 tons in the previous month. Similarly, there was a fall in the exports of general descriptions of steel from 19,253 tons in December to 16,251 tons in January, the decline being principally noticeable in the exports to British India, which fell to 3888 tons from 5882 tons in December. The exports to South Africa also dropped to 2543 tons from 3548 tons. In the case of plates and sheets, ⅛in. thick and over, the exports fell from 15,138 tons in December to 10,968 tons, whilst exports of plates and sheets under ⅛in. thick dropped from 12,898 tons to 10,187 tons. Exports of galvanised sheets also were down slightly to 20,632 tons from 21,558 tons, but the exports of tin-plates rose from 25,996 to 27,396 tons in January. Exports of tubes showed a substantial decrease to 16,979 tons from 20,866 tons in the previous month. South Africa, which in December took 3378 tons, received 2632 tons in January. The Indian total was 3804 tons, compared with 5260 tons in December. The reduction was most noticeable in the case of welded tubes, the exports of which fell from 14,152 tons in December to 10,950 tons in January. In the case of railway material the fall was even more pronounced, the figures being 13,672 tons for December and only 6899 tons in January. Of the quantity exported last month, 3784 tons represented new steel rails and 1425 tons sleepers, fish-plates, and sole plates. The most notable fall in the case of railway material was in the exports to South Africa, which in January were only 1299 tons, compared with 9081 tons in December. British India took the largest quantity of iron and steel in January, the total being 24,756 tons. South Africa came next with 19,674 tons and the Argentine third with 14,207 tons. Exports to Australia reached 13,209 tons. Russia, which absorbed 3100 tons in December, in January received only 363 tons.

The Pig Iron Market.

For the time being the pig iron market is in a state of confusion, and it is not easy to present a definite picture of the conditions ruling. The hematite position, in particular, is irregular, and whilst the majority of makers are quoting the advanced prices which were decided upon at the recent meeting at Harrogate, others appear less sure of the correct quotation. It is generally believed that the Federation is opposed to the increase and that this accounts for the lack of any official confirmation of the higher rates. It would seem, therefore, that the producers felt themselves justified in deciding upon the increase before obtaining the permission of the Federation. Little doubt is entertained, however, that the official confirmation will be forthcoming, and it is sufficiently difficult to obtain quotations at below the new prices to warrant their being regarded as the current market quotations. On the North-East Coast it is expected that some relief will be afforded the stringency in the market by the relighting of another furnace which will produce foundry. Two other furnaces are likely to be put into commission on the manufacture of basic iron. It is said that the shortage of coke prevents the production of foundry iron being increased sufficiently to meet the full requirements of the market, but it is perhaps not unnatural that the consuming side of the industry is inclined to think that the pig iron makers are somewhat dilatory in starting up fresh furnaces. At the moment the price for Cleveland foundry iron is nominal, as little new business is being transacted. The producers are not finding it easy even to meet specifications against current contracts and ask a premium of 5s. for delivery after June. In the Midlands the situation is becoming difficult and some of the important producers have retired from the market for foundry iron for the time being. Most of the business offering is on forward account, and here also a premium of 5s. is asked for delivery after the end of June. The general impression in all the pig iron producing districts is that prices will be advanced during the next week or so. This, of course, influences the producers' attitude towards entering into important forward commitments and also accounts for the desire of consumers to cover themselves at current rates. In the Lancashire market conditions are steady. Most consumers seem to be well covered and are showing little inclination to pay the 5s. premium which is asked for delivery over the second half of the year.

Scotland and the North

The Scottish steel works are operating almost at capacity and a large proportion of their output consists of material for the shipyards. It has been noticeable, however, that lately new business of a general description has been distinctly quiet, although this is regarded as being partly due to the winter weather interfering with outdoor work and causing a slowing up in the demand. The requirements of the shipyards are on a heavy scale, as can be judged from the fact that the merchant shipping under construction on the Clyde totals 300,000 tons. The position at the plate mills is excellent, and in several cases the works are assured of maintaining the present rate of operations for the next eight or nine months. The orders in hand for boiler plates are particularly good, but, as in other departments, little new business has come to hand during the past week or two. The marine engineers, like all other industries connected with shipbuilding, are in a good position, and are providing an outlet for substantial quantities of steel. The production of the sheet mills has been on a heavy scale since the end of last year, but fresh business of importance has been rather scarce, if the requirements of the motor manufacturers are left out of account. The Scottish re-rollers are working practically at capacity on the production of small bars, sections, and strip. Their position has been greatly improved through the decline of competition from English works which appear to have as much work in hand as can be dealt with comfortably. In this department buying has been confined to small parcels, but the general view seems to be that this is a temporary and seasonal phase. The demand is largely from home consumers. The prices of small bars have been advanced to £9 1s., plus zone extras, and subject to allowances on orders, including over 4 tons of a size. In Lancashire production is maintained at a good rate, and on the whole specifications against current contracts have been well maintained. The constructional engineers in this district are well employed, and it is expected that the demand from this industry will expand when the weather improves. There has been a fair demand for boiler plates, but new business has been on the quiet side.

Current Business.

General Refractories, Ltd., have leased for a period of ten years land containing deposits of silica sand at Carlops, Midlothian, and expect to commence working the deposits within a few weeks. The London, Midland and Scottish Railway has decided to commence work on two schemes for improvement at Heysham, involving a total expenditure of £38,000. The schemes will include the modernisation of buffer equipment, the provision of coaling plant, equipment of a berth with modern cranes, and additions to traffic sidings. The Fairfield Shipbuilding and Engineering Company, Ltd., has adopted plans for extending the brassfinishing shop at Govan-road, Glasgow. William Gray and Co., Ltd., West Hartlepool, have secured an order for a cargo steamer of 9300 tons deadweight for W. H. Cockerline and Co., Hull. A contract for a 9000-ton cargo and passenger vessel has been placed with William Denny and Bros., Ltd., Dumbarton, by F. Henderson and Co., Ltd., Glasgow. An order for two wreck lifting vessels of special design has been placed by the Port of London Authority with Ferguson Bros. (Port-Glasgow), Ltd. The South Indian Railway Administration has placed an order with William Beardmore and Co., Ltd., for the supply of 166 pairs of carriage and wagon wheels and axles and 90 pairs of wheels without axles. A group of single-storey north light factories is to be erected at Walsall on a 15-acre site as a speculation. The factories will be built in blocks covering 30 to 40 square feet. The Department of Overseas Trade announces that the following contracts are open for tender :—Indian Stores Department : superheating steel flues and solid-drawn steel boiler tubes (New Delhi, February 27th); Argentine State Oilfields Directorate : motor pumping set (Buenos Aires, March 11th); Arbil (Iraq) Electricity and Water Board : two 75-kW Diesel engine-driven D.C. generators and accessories, overhead line and service material (Baghdad, March 12th); Australia, State Electricity Commission of Victoria : solid-drawn steel boiler tubes (Melbourne, March 16th).

Copper and Tin.

The improvement in the tone of the electrolytic copper market, which took place last week, has been continued. The expansion in the volume of business has not been on an important scale, but sentiment has become much more cheerful. This is largely due to the more hopeful views which are entertained regarding the development of business in the United States. Buying in that country has improved to such an extent that the American domestic price has been increased by ¼ cent to 9½ cent. The inquiry from Central Europe and also from the Balkan countries has improved, and although a considerable proportion of this failed to materialise into actual business, the conditions have provided a marked contrast to those ruling for several weeks. Italian buying has been maintained, and it is said that some of the metal which has been taken by Balkan countries will find its way to Italy. Consumers in Central Europe also have shown more interest in the market than for some time, although buying from this quarter has been held up by financial restrictions. The copper statistics for January are being awaited with some interest, as it is expected that they will disclose an increase in the stocks. It is suggested, however, that this will not be a serious matter, since American consumers will probably be obliged to come into the market shortly to replenish their holdings. Active conditions have ruled in the London standard copper market, and prices sharply appreciated at the end of last week when sellers showed reserve in the face of more active buying. . . . This week interest in the tin market has centred upon the outcome of the meeting of the International Tin Committee, fixed for February 19th. There has been considerable discussion as to the possibilities of an increase in the quota, and it has been pointed out that since it has been raised to 90 per cent. prices have declined rather heavily. The general view, however, seems to be that in spite of the pressure which may be brought to bear to get the quota reduced, it will probably be maintained at 90 per cent. The stocks in this country are still small, and a premium is charged for tin delivered from London warehouse. The backwardation remains at between £6 and £7, and the market apparently does not think that this position is justified by the situation, and is inclined to regard it as the result of manipulation.

The Lead Market.

The lead market took a turn for the better at the end of last week, after having passed through rather a quiet period. Prices advanced and although the expectation of fresh buying for munition purposes in various parts of the world may have encouraged a certain amount of speculation, the movement was based on a noticeable increase in the demand for industrial purposes. Producers have continued to sell freely, but the consuming trades have shown considerable interest in the market, and the demand looks like expanding if the weather becomes more open. There is no doubt that the check to building operations owing to the severe weather was reflected in a decline in buying by manufacturers of materials used by the building trades. Recently some Burma lead was declared on the market, and this attracted some attention, since for a long time all the Empire lead reaching this country has gone direct into consumption. As a result of this declaration a small contango developed. Interesting reports are current that the Empire lead producers are conducting negotiations with the Mexican producers with the object of reaching an agreement regarding supplies to the British market. No official statement has been made as to the accuracy of the report. Since the Mexican strike, all the lead from that country has been shipped to the Continent, but it is possible that as conditions in Mexico become more normal, some surplus metal may become available for the British market.

Current Prices for Metals and Fuels.

Makers' official home trade prices per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. * For Markets other than Canada, India, South Africa, Australia and New Zealand 5s. per ton must be added.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. COAST—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 16 6	3 2 0
No. 1	3 17 0	3 3 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 12 6	3 4 0
No. 3 G.M.B.	3 10 0	3 1 6
No. 4 Forge	3 9 0	3 0 6
Basic (*Less 5/- rebate*)	3 10 0	—
MIDLANDS—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 15 0	—
„ „ Forge	3 10 0	—
Basic (*Less 5/- rebate*)	3 15 0	—
Northampton—		
Foundry No. 3	3 12 6	—
Forge	3 7 6	—
Derbyshire—		
No. 3 Foundry	3 15 0	—
Forge	3 10 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 17 0	—
No. 1 Foundry, ditto	3 16 6	—
No. 3 Foundry, ditto	3 14 0	—
Basic, d/d (*Less 5/- rebate*)	3 10 0	—
N.W. COAST—	3 17 0 d/d Glasgow	
Hematite Mixed Nos.	4 2 6 „ Sheffield	
	4 8 6 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
LANCS.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. YORKS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
MIDLANDS—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
No. 3 quality	7 17 6	—
No. 4 „	8 10 0	—
SCOTLAND—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. COAST—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

LONDON AND THE SOUTH—	Home.	Export.
	£ s. d.	£ s. d.
Angles	8 10 0	*7 10 0
Tees	9 10 0	*8 10 0
Joists	8 17 6	*7 10 0
Channels	8 15 0	*7 15 0
Rounds, 3in. and up	9 10 0	*8 10 0
„ under 3in.	9 3 6	7 0 0
Flats, 5in. and under	9 3 6	7 0 0
Plates, ¼in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 10 0	9 0 0
NORTH-EAST COAST—	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	*8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
„ under 3in.	9 1 0	7 10 0
Plates, ¼in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	9 0 0
Boiler Plates, ¼in.	9 5 0	—
MIDLANDS, AND LEEDS AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	*8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
„ under 3in.	9 1 0	7 10 0
Flats, 5in. and under	9 1 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 5 0	9 0 0
Boiler Plates, ¼in.	9 7 6	7 15 0

STEEL (*continued*).

GLASGOW AND DISTRICT—	Home.	Export.
	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
„ under 3in.	9 1 0	7 10 0
Flats, 5in. and under	9 1 0	8 17 6
Plates, ¼in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	9 0 0
Boiler Plates	9 5 0	—
SOUTH WALES AREA—	£ s. d.	£ s. d.
Angles	8 7 6	*7 10 0
Tees	9 7 6	*8 10 0
Joists	8 15 0	*7 10 0
Channels	8 12 6	*7 15 0
Rounds, 3in. and up	9 7 6	*8 10 0
„ under 3in.	9 1 0	7 10 0
Flats, 5in. and under	9 1 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 10 0	9 0 0

IRELAND—	BELFAST.	REST OF IRELAND.
	£ s. d.	£ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G. to 13-G., f.o.r.	9 15 0	9 0 0
14-G. to 20-G., d/d	11 5 0	9 10 0
21-G. to 24-G., d/d	11 10 0	9 15 0
25-G. to 27-G., d/d	12 2 6	10 7 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24

Home.	£ s. d.
4-ton lots and up	13 10 0
2-ton to 4-ton lots	13 17 6
Under 2 tons	15 10 0

Export: £12 15s. 0d., c.i.f. India.
„ £11 15s. 0d., f.o.b. other markets.
„ Scandinavia: £10 10s. 0d. to £10 15s. 0d. f.o.b.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18s. 9d.
Tin-plate Bars, d/d Welsh Works, £5 10s. 0d. to £5 15s. 0d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	7 0 0
„ Medium (0·42% to 0·60% C.)	7 10 0
„ Hard (0·61% to 0·85% C.)	8 0 0
„ „ (0·86% to 0·99% C.)	8 10 0
„ „ (1% C. and up)	9 0 0
Soft (up to 0·25% C.), 500 tons and up	5 17 6
100 to 250 tons	6 5 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/- per lb.	
	Per Ton.	Per Unit.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/-
„ „ 6 p.c. to 8 p.c.	£21 0 0	7/-
„ „ 8 p.c. to 10 p.c.	£21 0 0	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£33 10 0	11/-
„ „ „ 1 p.c. carbon	£36 5 0	11/-
„ „ „ 0·50 p.c. carbon	£37 5 0	12/-
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose), 76 p.c.	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/- p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/- p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/3 per lb.	

NON-FERROUS METALS.

Official Prices, February 19th.

		Home.	Export.
COPPER—			
Cash	£35 15 0 to £35 17 6		
Three months	£36 2 6 to £36 3 9		
Electrolytic	£40 0 0 to £40 10 0		
Best Selected Ingots, d/d Birmingham	£40 5 0		
Sheets, Hot Rolled	£68 0 0		
		Home.	Export.
Tubes, Solid Drawn (basis)		10½d.	10½d.
„ Brazed (basis)		10½d.	10½d.
BRASS—			
Ingots, 70/30, d/d Birmingham	£32 0 0 to £33 0 0		
		Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy		9¾d.	9¾d.
„ Brazed		11¾d.	11¾d.
TIN—			
Cash	£207 10 0 to £207 15 0		
Three months	£200 10 0 to £200 12 6		
LEAD	£16 8 9 to £16 10 0		
SPELTER	£15 6 3 to £15 11 3		
Aluminium Ingots (British)	£100		

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Grangemouth)—Navigation Unscreened	16/- to 16/6
Hamilton Ell	20/- to 21/-
Navigation Splints	21/- to 22/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	15/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	15/6
Unscreened Navigation	15/- to 15/6
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime	16/- to 16/6
Secondary Steam	15/- to 15/6

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	19/6 to 23/-
Furnace Coke	14/6 to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	15/6 to 16/-
„ Second	14/6 to 15/-
„ Best Small	11/- to 11/6
Unscreened	13/6 to 15/-
DURHAM—	
Best Gas	14/8 to 15/-
Foundry Coke	20/- to 23/-

SHEFFIELD—	Inland.	
Best Hand-picked Branch	26/- to 29/-	—
South Yorkshire Best	23/- to 25/-	—
South Yorkshire Seconds	20/- to 21/-	—
Rough Slacks	11/- to 12/-	—
Nutty Slacks	10/- to 11/-	—

CARDIFF— SOUTH WALES.	
Steam Coals:	
Best Admiralty Large	19/6
Best Seconds	19/- to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Bunker Smalls	12/6 to 13/6
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/- to 27/6
Foundry Coke	27/- to 40/-
Furnace Coke	19/- to 22/6
Patent Fuel	21/-
SWANSEA—	
Anthracite Coals:	
Best Large	36/- to 40/-
Machine-made Cobbles	41/- to 48/6
Nuts	40/- to 48/6
Beans	25/- to 35/-
Peas	19/- to 23/-
Rubbly Culm	11/6 to 12/-
Steam Coals:	
Large Ordinary	18/- to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

French Engineering Notes.

(From our own Correspondent in Paris.)

Engineering Outlook.

OCCASIONAL spurts of moderate activity indicate that there are elements of recovery in the engineering trades which are only kept in check by the seriousness of the financial situation. For the moment, work is provided mainly by national defence requirements, both home and foreign, and in a smaller degree by public relief undertakings which can only exert their full effect when the State is able to provide the necessary funds. No general recovery is possible until private enterprise is encouraged by a return of confidence. Rarely has the demand for structural iron and steel from private consumers been so small, and stocks are kept so low that the demand for all kinds of material is likely to be particularly heavy when the cloud of economic depression begins to lift. The situation is marked by a feeling of disappointment over the Government's failure to deflate values and lower production costs, and of uncertainty as to what will come of the Government's further efforts to improve matters by means of financial operations and commercial arrangements with foreign countries, such as the one recently signed with Roumania, which undertakes to purchase a considerable quantity of war material. If the belief in an adjustment of long-standing commercial differences with Belgium is confirmed it will do much to promote confidence. The Government has obtained from Parliament a renewal of powers to offer concessions when negotiating commercial agreements, notably a reduction of import duties to below the statutory minimum. These powers will permit of negotiations being continued for reciprocal concessions by means of lower tariffs to countries that consent to waive the most-favoured-nation clause, which is regarded here as inapplicable in present circumstances.

Collapse of Cableway.

A cableway installed for the construction of the new Carrousel bridge in Paris collapsed last week, and a cabin fell into the Seine with three men, who were drowned. The towers carrying the cable are mounted on rollers running on rails for displacement as work on the bridge proceeds, and while the rails on the outer or pressure side of the tower now standing are inclined on a bank, there is no such banking for the tower which collapsed on the concrete embankment on the Louvre side of the river. The towers are more than 100ft. high, and the distance between them is about 550ft. They are of rectangular section at the base, and the elevation is a right-angled triangle—that is to say, two girders rise vertically and join at the apex two other girders inclined from the opposite side of the rectangle. The girders are built up of light angles and are braced half way up and at the base with similar horizontal girders, the lower bracing being extended and doubled to provide space for an apparently adequate stack of rails under the vertical girders to serve as counterweight. Now that the piers of the new Carrousel bridge are nearing completion, the cableway was installed recently in readiness for work on the superstructure. It had already undergone two preliminary tests, and the cabin was crossing with three men when the tower collapsed. The vertical girders broke away at rivets and the inclined girders bent at the base, while the counterweight tipped up. Although the construction of the tower appears light, nothing can be said about the probable cause of the accident pending an inquiry now being made.

The Engineers' Federation.

Complaints formerly made that the Fédération des Associations, Sociétés et Syndicats Français d'Ingénieurs, representing 55,000 out of a total of about 60,000 engineers in this country, failed to make full use of its authority to accelerate reforms of interest to engineers, were disposed of in a report presented at the annual meeting of the Federation upon the work accomplished during the past year. There may have been some ground for belief in the past that the Federation displayed more prudence than initiative, and some attempts to improve the status of engineers were made outside the body; but recent achievements in giving an official character to degrees and rendering their misuse illegal, and in carrying through the new patent law and other matters, are largely due to its collaboration. The industrial crisis has raised so many new problems affecting the profession, which has expanded beyond industrial needs, that the Federation is inquiring into every aspect of those problems and is endeavouring to determine what the needs are likely to be in normal times, and to extend the sphere in which the engineer may find occupation. The main object is to secure for him a place in councils affecting relations between employers and men, as well as on administrative bodies. In a word, more is to be made of the intellectual factor in all economic and industrial matters. During the Exhibition in Paris next year it is proposed to hold an important congress of engineers, which, it is hoped, will settle questions of a national and, perhaps, international character concerning the work of engineers.

Iron and Steel Output.

Figures of iron and steel production during 1935 issued by the Comité des Forges show that pig iron totalled 5,799,000 tons, or 352,000 tons less than in 1934, while the production of raw steel was 6 264,000 tons, an increase of 90,000 tons. The record tonnage of steel was 9,700,000 tons in 1929. The contraction is attributed to the smaller demand of home consuming industries, principally the railways, shipbuilding, motor car manufacture, and engineering. The steel trade was also unsettled by the precarious situation of the sales Comptoir, which was renewed after long and difficult negotiations in November last, and efforts are now being made to organise distribution by merchants in a manner to ensure that they will receive fair discounts under a rigorous system of selling prices. It is hoped to fix quotas for stocks in merchants' warehouses and pool orders in local districts so as to avoid incentive to illicit underselling.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

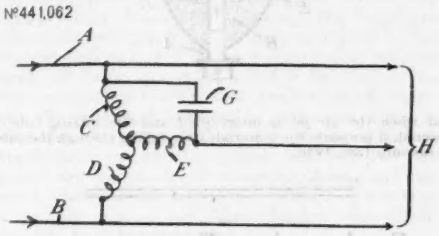
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

441,062. July 6th, 1934.—PHASE-CHANGING ARRANGEMENTS, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2, and Arthur Hemborough Maggs, of 14, Oval-road, Rugby.

This invention has reference to the Ferraris Arno system of phase conversion which is commonly used to obtain a three-phase supply from a single phase source. The diagram shows the elementary connections of the combination of a three-phase

Nº441,062



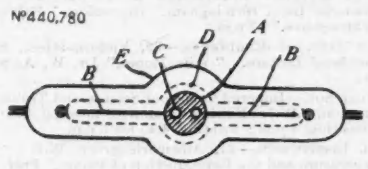
induction motor and condenser in accordance with the invention. For simplicity, only the stator or primary winding of the motor is represented. A and B represent the single-phase supply lines, C, D, and E the stator windings of the induction motor, and G represents the condenser connected between the terminals of the windings C and E. The lines H form the three-phase supply to the load. The invention also relates to the combination of an induction motor with a "capacitance inductance" network instead of a condenser alone.—*January 6th*, 1936.

TELEGRAPHS AND TELEPHONES.

440,780. May 21st, 1935.—CATHODES FOR ELECTRIC DISCHARGE TUBES, N. V. Philips' Gloeilampenfabrieken, of Emmasingel, Eindhoven, North-Brabant, The Netherlands.

In electric discharge tubes, particularly those for use in radio receivers for amplifying electric oscillations and for similar purposes, a steep static characteristic is often desired. A cathode body A is provided with projections B secured with a heater C.

Nº440,780



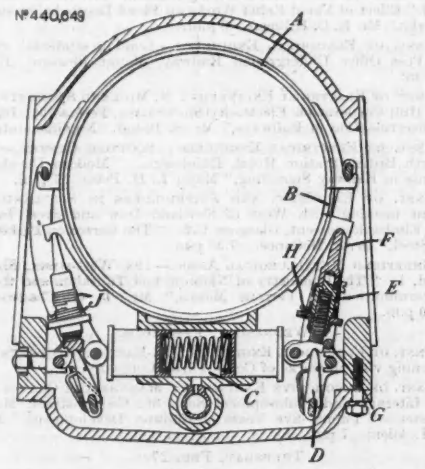
The grid and anode are shown at D and E respectively. The cathode body A and the projections B, which are preferably made of copper, are coated with a thin layer of barium oxide or other electron-emitting material. The emitting layer should preferably have a thickness of about 0·05 mm. in order that its heat radiation may not unfavourably influence that of the carrier material.—*January 6th*, 1936.

MOTOR CARS AND ROAD TRAFFIC.

440,649. June 29th, 1934.—BAND BRAKE ADJUSTING MECHANISM, Joseph Ylxall, York House, Deganwy, North Wales.

This is a mechanism for automatically adjusting brake bands as they wear. There are two brake bands A and B of opposite hands. They are applied by the hydraulic cylinder C straightening out the toggle link system D E F. The extent of this move-

Nº440,649

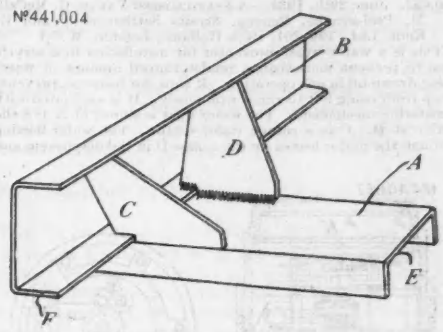


ment is checked by the stop G. As the toggle E passes between the two cheeks of the toggle F the catch H engages one of them and unscrews the two pieces of E so as to lengthen the toggle and tighten up the band. When, however, the mechanism has adjusted itself so that the brake is fully applied before the catch H touches the cheek of F, this action ceases. The springs J provide a clutch action between the two parts.—*December 30th*, 1935.

441,004. May 4th, 1934.—WELDED FRAME JOINTS, C. D. Magirus Aktiengesellschaft, of Ulm-on-the-Danube, Germany, and Karl Schroeder, of 9, Seutterweg, Ulm-on-the-Danube, Germany.

The welded frame joints described in this specification are applicable more particularly to the chassis of motor vehicles. The object is to make rigid the joints formed between the longitudinal and transverse frames. The transverse frame

Nº441,004



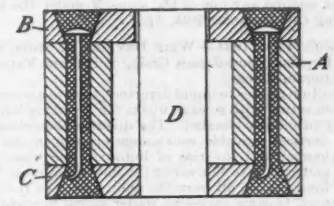
member A is constrained in position relatively to the longitudinal frame member B by the walls or plates C and D. These plates engage in the open section of the longitudinal frame member B, so as to be situated in planes inclined to the longitudinal axis of the frame member B, and are welded to the upper flange and to the bottom flange of the longitudinal frame member and to the transverse frame member A. The body part E of the transverse frame member is welded directly to the flange F. Two alternatives are described.—*January 6th*, 1936.

ELECTRICAL APPLIANCES.

440,279. August 8th, 1934.—PERMANENT MAGNETS, C. A. Gardner, "The Cote," Snaithing-lane, Sheffield, 10, and A. C. Gardner, 197, Crimicar-lane, Sheffield, 10.

The inventors' assemble a permanent magnet, such as that shown in the illustration, of parts comprising a magnetisable

Nº440,279



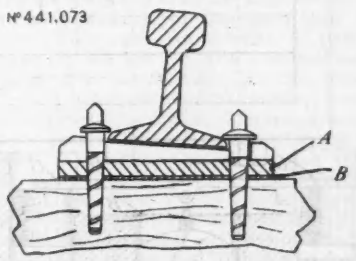
yoke A, in which there are longitudinal holes, two iron pole plates B and C with corresponding countersunk holes, and a pole piece D. They then pour or force molten non-magnetisable metal into the holes to hold the parts together. The name of the metal is not disclosed, but it may be reinforced with pins, as shown.—*December 24th*, 1935.

TRAMWAYS AND RAILWAYS.

441,073. July 11th, 1934.—PERMANENT WAYS, Dr. Myrti Kahn, of 7, Bodinusstrasse, Köln-Riehl, Germany.

The object of this invention is to avoid the noise of rolling stock on metal rails. At least one sheet of a soft rubber material

Nº441,073



A, such as natural or synthetic rubber, is interposed between rail and sleeper with the aid of an intermediate adhesive layer B of strongly adhesive rubber or rubber resins, so that an intermediate layer is firmly attached to at least one horizontal or substantially horizontal surface.—*January 13th*, 1936.

MISCELLANEOUS.

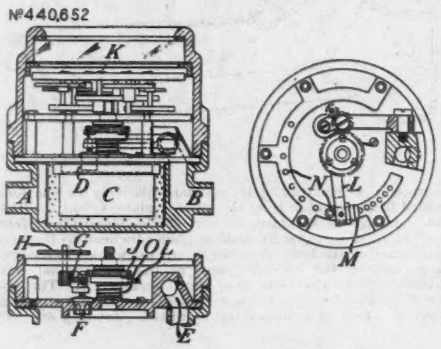
441,088. July 13th, 1934.—PROTECTIVE OR PAINT-HOLDING COATINGS ON ALUMINIUM OR ALUMINIUM ALLOYS, The Pyrene Company, Ltd., of Great West-road, Brentford, Middlesex, and Edwin Cecil Frederick King, of the same address.

It is known that a solution of an alkali metal carbonate and an alkali metal chromate produces protective films on aluminium or non-cuprous aluminium alloys, and for the purpose of affecting the colour of the film it has been proposed to add very small amounts of the salts of certain metals (including manganese) to a bath of this kind containing a relatively large proportion of alkali metal carbonate. According to the invention, denser and harder films are produced by making certain additions to solutions which essentially comprise such carbonates and chromates. These additions comprise broadly the neutral salts of an alkali metal and those carbonates, including basic carbonates of a metal electro-negative with respect to aluminium which do not react with any of the other constituents of the solution, and any one or more of these bodies may be added to the coating solution. Examples of suitable neutral salts of alkali metals are sodium monohydrogen phosphate, sodium chloride, and sodium nitrate, while examples of suitable metallic carbonates are chromium carbonate, and the carbonates of nickel, cobalt, manganese, and titanium. Iron carbonate reacts with the sodium carbonate in the solution, and is therefore unsuitable. According to one example of the process given in the specification, an article which may, if desired, be previously cleaned by degreasing with trichlorethylene is treated for three to five minutes in a bath kept at boiling temperature, and pre-

pared by dissolving in 100 parts by weight of water, nine parts by weight of the following composition :—Sodium carbonate, 72·7 parts by weight ; sodium chromate, 24·2 parts by weight ; sodium monohydrogenphosphate, 3·0 parts by weight. After treatment the article is rinsed in hot water. It is then ready for use for the reception of paints, lacquers, enamels, and the like, or, alternatively, the treated surface may be further protected by treatment with a substance such as lanoline.—*January 13th*, 1936.

440,652. June 29th, 1934.—A SELF-CLOSING VALVE, G. McCall, 31, Peel-avenue, Penang, Straits Settlements ; and G. Kent, Ltd., 199–201, High Holborn, London, W.C.1.

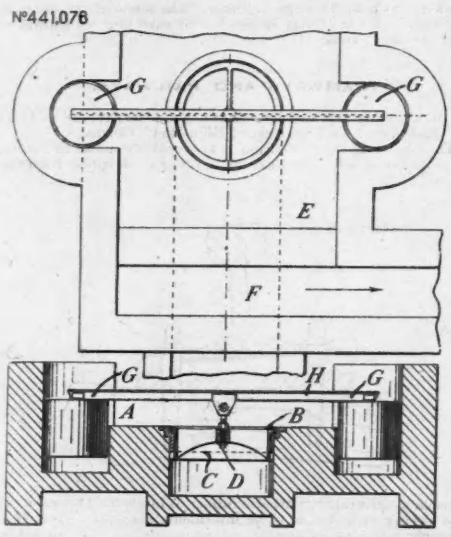
This is a water waste preventer for installation in a service pipe to prevent more than a predetermined amount of water being drawn off in one operation. It thus, for instance, prevents a tap from being left to run continuously. It is associated with a metering mechanism. The water inlet is shown at A and the outlet at B. C is a rotary water motor. The water flowing through the motor leaves by the orifice D in the diaphragm and



the opening E leading to the outlet. The orifice D is controlled by the valve F, on whose spindle there is a loose gear wheel G. When the pressure of the water opens the valve the wheel G is lifted into engagement with the wheels H and J and the motor drives the counting mechanism K. At the same time the arm L starts to rotate counter-clockwise from the position shown. This arm carries the valve M, which finally closes the opening E and cuts off the water. Equilibrium of pressure is then produced throughout the casing and the valve F closes. The arm L then swings back against any one of the stops N under the influence of the spring O.—*December 30th*, 1935.

441,076. July 12th, 1934.—WEIR DEVICES, J. Stone and Co., Ltd., Deptford, and James Craig, of Bretons Farm, South Hornchurch, Essex.

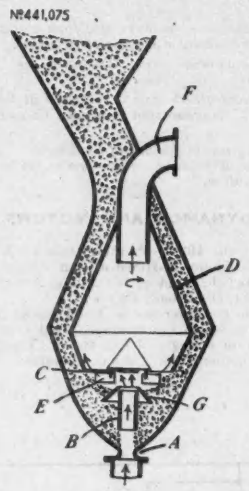
This invention relates to liquid diverters, such as are commonly fitted in connection with sewage works for diverting liquid from a main to a subsidiary channel. The diverter comprises a float-controlled vertical movable weir gauge or gate in the floor of its main channel and the rise of liquid in the main channel causes the gauge or gate to restrict the flow of liquid so that the amount of liquor taken off from the main flow into the diverter channel cannot become excessive under storm flow conditions. In the ordinary way, liquid flows along the main channel A over the circular edge B of the cylindrical weir device C and into the channel D leading to the filters. The normal flow along the



channel A is dammed by the storm water weir E beyond the cylindrical weir C, so that liquid flows over the latter from all sides and none will pass over the weir E to the storm water overflow channel F. When there is an abnormal rise of level in the channel A, owing to the presence of storm water, water passes over the weir E into the overflow F. This general rise of level in the main channel A would result in an undesirable amount of liquid being passed over the cylindrical weir C into the duct D leading to the filters. This rise of level, however, causes the floats G to rise so that the yoke or cross bar H raises the cylindrical weir device C to cut down the excess flow to the filters which otherwise would take place. When the storm water has passed and the general level or head of liquid falls, the consequent descent of the floats will lower the cylindrical weir C to its position of rest on the seating in the mouth of the inset frame or casing, and thereby restore normal working.—*January 13th*, 1936.

441,075. July 12th, 1934.—JET IMPACT PULVERISERS, Paul Anger, of 59A, Beseler Allee, Kiel, Germany.

The invention consists in the provision of means for feeding the raw material to the jet nozzle of an impact pulveriser, so that it will be uniformly distributed about the nozzle. The pulveriser comprises an upright, funnel-shaped vessel, having at the bottom a nozzle A, through which an air blast is admitted for blowing materials contained in the vessel through a mixing pipe B against an impact member C. The latter is covered by a hood D, over which the materials are fed into the vessel, the hood forming between it and the vessel wall an annular passage through which the materials descend for uniform distribution about the mixing tube B and the jet nozzle. The materials are broken up and scattered by the impact member, and the mixture of air and comminuted materials is deflected by tangentially disposed vanes E and set in a whirling motion. The coarser materials drop back into the vessel for renewed treatment, and the dust-laden air rises through the hood, and is discharged through a pipe F. A conical screen G is provided,



and when the air jet is interrupted and the mixing tube B lowered, it prevents the materials from falling through the tube.—*January 13th*, 1936.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF ELECTRICAL ENGINEERS : LONDON STUDENTS' SECTION.—Savoy-place, W.C.2. "Electricity and the Farmer," Mr. A. L. Cain. 6.30 for 7 p.m.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND : STUDENTS' SECTION.—39, Elmbank-crescent, Glasgow, C.2. "Works Maintenance and Production," Mr. D. Carmichael. 8 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Annual general meeting. Dr. H. J. Gough will present First Report of the Pipe Flanges Research Committee. 5.30 p.m.

INST. OF METALS : BIRMINGHAM LOCAL SECTION.—James Watt Memorial Inst., Birmingham. Discussion, "Fabrication of Metal Structures." 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Hon. Members' Lecture. "Wire Ropes," Dr. W. A. Scoble. 7.30 p.m.

PHYSICAL SOC.—Imperial College of Science and Technology, S. Kensington, S.W.7. Editing Committee meeting, 3.30 p.m.; Council meeting, 4 p.m.; meeting, 4.45 for 5 p.m.

ROYAL INSTITUTION.—21, Albemarle-street, W.1. "Light and Temperature and the Reproduction of Plants," Prof. V. H. Blackman. 9 p.m.

TO-DAY TO FRIDAY, FEB. 28th.

BRITISH INDUSTRIES FAIR.—Castle Bromwich, Birmingham, daily. London, daily.

SATURDAY, FEB. 22ND.

INST. OF ELECTRICAL ENGINEERS : S. MIDLAND STUDENTS' SECTION.—Visit to British Industries Fair, Castle Bromwich.

MONDAY, FEB. 24TH.

INST. OF ELECTRICAL ENGINEERS : N. EASTERN CENTRE.—Armstrong College, Newcastle-upon-Tyne. "The Development of the Single-break Oil Circuit Breaker for Metal-clad Switchgear," Messrs. D. R. Davies and C. H. Flurscheim. 6.15 p.m.

INST. OF MECHANICAL ENGINEERS : GRADUATES' SECTION.—Storey's-gate, St. James's Park, S.W.1. "Locomotive Valve Practice," Mr. R. Purdie. 6.45 p.m.

TUESDAY, FEB. 25TH.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. "St. Germans Sluice and Pumping Station," Mr. R. G. Clark ; and "Effect of Flood Relief Works on Flood Levels below such Works," Mr. E. C. Hillman. 6 p.m.

INST. OF ELECTRICAL ENGINEERS.—London students' visit to Post Office Underground Railway, Mount Pleasant, E.C. 7 p.m.

INST. OF ELECTRICAL ENGINEERS : N. MIDLAND STUDENTS.—At Hull Corporation Electricity Showrooms, Ferensway, Hull. "Electrification of Railways," Mr. S. Blund. No time stated.

INST. OF ELECTRICAL ENGINEERS : SCOTTISH CENTRE.—At North British Station Hotel, Edinburgh. "Modern Developments in Railway Signalling," Major L. H. Peter. 7 p.m.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Joint meeting with West of Scotland Iron and Steel Inst. 39, Elmbank-crescent, Glasgow, C.2. "The Corrosion Problem in Steel," Dr. A. McCance. 7.30 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. "The Chemistry of Niobium and Tantalum and their Determinations in Ferrous Metals," Mr. T. G. Chadwick. 7.30 p.m.

WEDNESDAY, FEB. 26TH.

INST. OF ELECTRICAL ENGINEERS : N.-EASTERN STUDENTS.—Evening visit to works of Consett Iron Company.

INST. OF LOCOMOTIVE ENGINEERS : MANCHESTER CENTRE.—At Literary and Philosophical Soc., 36, George-street, Manchester. "Twenty-five Years of Railway Development," Mr. C. J. Allen. 7 p.m.

THURSDAY, FEB. 27TH.

INST. OF CIVIL ENGINEERS.—Hôtel Metropole, Leeds. Vernon Harcourt Lecture, "Tidal and River Models," Prof. A. H. Gibson. 7.30 p.m.

INST. OF CIVIL ENGINEERS : BIRMINGHAM AND DISTRICT ASSOC.—James Watt Memorial Inst., Birmingham. "Lambeth Bridge," Mr. G. L. Groves. 5.30 for 6 p.m.

INST. OF ELECTRICAL ENGINEERS : N. MIDLAND STUDENTS.—Visit to Messrs. Hield Brothers, Springfield Mills, Morley. 7 p.m.

INST. OF PRODUCTION ENGINEERS.—At Inst. of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow, C.2. "Engineering Conditions in Russia," Mr. Allan Monkhouse. 7.30 p.m.

INST. OF STRUCTURAL ENGINEERS.—Joint meeting with British Section of Soc. des Ingénieurs Civils de France. 10, Upper Belgrave-street, S.W.1. "The Strengthening of Weak Bridges," Mr. C. S. Chettoe. 6.30 p.m.

N. EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—At Mining Inst., Newcastle-upon-Tyne. "The Wake and Thrust Deduction of Single-screw Ships," Dr. E. V. Telfer. 6 p.m.

FRIDAY, FEB. 28TH.

DIESEL ENGINE USERS ASSOCN.—At Caxton Hall, Caxton-street, S.W.1. Discussion, "The Report of the Committee on Heavy-oil Engine Working Costs (1934–35)." 5.30 p.m.

INST. OF CIVIL ENGINEERS : BIRMINGHAM AND DISTRICT ASSOC.—Visit to British Industries Fair, Castle Bromwich. Luncheon in Bradford Dining Room. 1 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Informal lecture, "Gears for Automobiles," Mr. R. O. Baird. 7.30 p.m.

INST. OF ELECTRICAL ENGINEERS : N.-EASTERN STUDENTS.—Joint meeting with Graduate Section of N.E. Coast Inst. of Engineers and Shipbuilders. "The Development of Steam Turbines," Mr. P. Richardson. 7 p.m.

N. EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS : GRADUATES.—Joint meeting with Inst. of Electrical Engineers. Armstrong College, Newcastle-upon-Tyne. "Developments in Steam Turbines," Mr. F. Richardson. 7.15 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse, "World Air Transport," The Lord Sempill. 9 p.m.

MONDAY, MARCH 2ND.

INST. OF TRANSPORT.—Joint meeting with British Section of Soc. des Ingénieurs Civils de France. At Inst. of Electrical Engineers, Victoria Embankment, W.C.2. "Mechanical Traction on French Waterways," Monsieur L. P. Alvin. Discussion. 5.30 for 6 p.m.

TUESDAY, MARCH 3RD.

INST. OF AUTOMOBILE ENGINEERS.—Joint meeting of Engineering Societies, in the Hall of the Royal Geographical Soc., Kensington Gore, S.W.7. Symposium of short papers on "Railcars." 7 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. "Road Engineering Problems : Judging the Slippery Road," Mr. R. G. C. Batson, Mr. G. Bird, and Dr. R. E. Stradling. 6 p.m.

WEDNESDAY, MARCH 4TH.

INST. OF ELECTRICAL ENGINEERS : N. EASTERN CENTRE.—At Literary and Philosophical Soc., Westgate-road, Newcastle-upon-Tyne. Faraday Lecture, "Television—An Outline," Dr. E. Mallett. 7 p.m.

SOC. OF GLASS TECHNOLOGY : LONDON SECTION.—Visit to Osram-G.E.C. Glass Works, N. Wembley. Paper, "Glassware Finishing Machinery, with Special Reference to Table Ware," Mr. E. Venis. 7 p.m.

THURSDAY, MARCH 5TH.

INST. OF ELECTRICAL ENGINEERS : LONDON STUDENTS' SECTION.—Pinoli's Restaurant, 17, Wardour-street, London, W.1. Twenty-ninth annual dinner. 7.15 for 7.30 p.m.

FRIDAY, MARCH 6TH.

INST. OF CHEMICAL ENGINEERS.—Hotel Victoria, Northumberland-avenue, W.C.2. Fourteenth annual meeting. 11 a.m. Presidential address, "The Grant of Trading Monopolies—Then and Now," Dr. Herbert Levinstein, 11.45 a.m.; informal luncheon, 12.45 p.m.; paper, "The Dead Sea—A Storehouse of Chemicals," Mr. M. Novomeysky, 2.15 p.m. The annual dinner is postponed.

INST. OF ELECTRICAL ENGINEERS : N. MIDLAND CENTRE.—Hotel Metropole, Leeds. Annual dinner. 7 for 7.30 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Informal meeting. "The Importance in Practice of the Lower Yield Point in Mild Steel," introduced by Professor B. P. Haigh. 7 p.m.

INST. OF SANITARY ENGINEERS.—Caxton Hall, S.W.1. "Specifications—The Engineer's Point of View," Mr. K. C. Iliffe. 6.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Informal lecture, "Mono Pumps," Mr. J. Armes. 7.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WELLWORTHY PISTON RINGS, Ltd., is to acquire the business of Wellworthy, Ltd., manufacturers of piston rings and pistons, at Lymington, Hants.

MR. W. ELLISON SHARPLES, A.M.I. Ch. E., informs us that he has set up in private practice as a consulting engineer at 97, Bridge-street, Manchester, 3. Mr. Sharples was formerly chief engineer to Harbens, V.S.M., Ltd., rayon manufacturers, and at an earlier period was on the engineering staff of Lever Brothers, Port Sunlight.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

CROMPTON PARKINSON, Ltd., has received an order from Guest Keen and Nettlefold, Ltd., Birmingham, for approximately 400 A.C. motors and starters, to the value of about £8000, for installation in the Birmingham factory, in connection with frequency change operations.

DAVEY, PAXMAN AND CO. (COLCHESTER), Ltd., are to supply a 150 b.h.p. Paxman-Ricardo high-speed oil engine fitted with reverse and reduction gears, also the auxiliary engine sets, for a dredger which is to be built for the Whitby District Council by Henry Robb, Ltd., of Leith. They have also received among other orders one for a 275 b.h.p. and a 220 b.h.p. oil engines which are to form the main power unit for a floating shore plant and a cutter dredge for Liege, together with auxiliary engines of 66 b.h.p., 13½ b.h.p., and 57 b.h.p.

SIR W. G. ARMSTRONG, WHITWORTH AND CO. (ENGINEERS), Ltd., have received an order from the Western Australia Government Railways for six 140/160 b.h.p. light railcars, similar to the six running on the Madras and Southern Mahratta Railway, and those used by the G.I.P. and N.W. Railways (India), and B.A. Western Railway. One railcar will be shipped complete with body, while for the other five cars the body framing, outer panelling, seats, and fittings will be sent abroad for erection and interior finishing by the railway. Special trailers for these cars are being manufactured abroad.